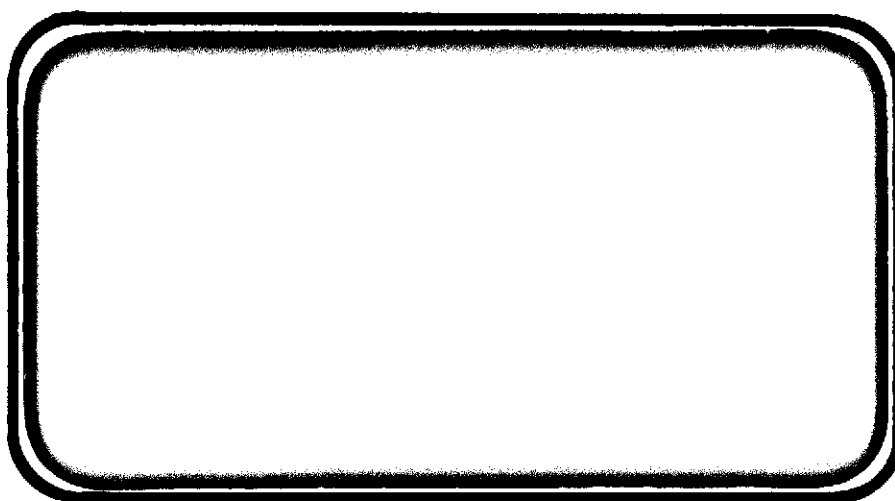




# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



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AEROTHERMODYNAMIC DATA REPORT

JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANAGEMENT services

SPACE DIVISION



CHRYSLER  
CORPORATION

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INVESTIGATION OF CONFIGURATION EFFECTS

ON ENTRY HEATING DISTRIBUTIONS

AT MACH NO = 8.0 (OH41)

BY

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Prepared under NASA Contract Number NAS9-13247

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FOR

Engineering Analysis Division  
Johnson Space Center  
National Aeronautics and Space Administration  
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test No.: LARC VDT 3778/3855  
NASA Series No.: OH41  
Date: March 19-28, 1973

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## SUMMARY

Aerodynamic heating data were obtained on 0.006 scale models of four Rockwell International SSV double delta wing Orbiters in the NASA/LRC - Mach 8 Variable Density Tunnel. A model of two previously tested Rockwell International Orbiters which are identified in the Configuration Description of this report were also tested. Orbiter surfaces were thermally mapped from the laminar through turbulent flight regimes during re-entry. Various modifications were made to model lower surfaces to determine the cause of transition in the vicinity of 3.0 million Reynolds number per foot. Holes were drilled at various locations on one model in order to simulate the forward tank attachment bay on the orbiter lower surfaces and the RCS opening on the orbiter side. Re-entry data were acquired for angles of attack from 25 through 35 degrees at nominal Reynolds numbers per foot of 1.0, 2.0, 2.3, 2.5, 3.0, 3.5, 4.5 and 6.0 million utilizing the phase change paint technique. Launch data were acquired on the model upper surfaces for angles of attack of 0 and -5 degrees at nominal Reynolds numbers per foot of 3.0 and 6.0 million. A total of 70 orbiter heating runs and 6 material sample sphere runs were completed from March 19 through March 28, 1973 on a 40 hour week basis.

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## DESCRIPTION OF MODEL

The four primary test models are 0.006 scale external replicas of the Rockwell International 2A Lightweight Configuration double delta wing orbiter as described on drawings VL 70-000089B, VL 70-000092A and VL 70-000093 with modifications as shown in Figures 1, 2 and 3. They have been designated as 33-0.

In order to insure sufficient valid data acquisition time, the upper surface of each wing was slabbed using two control sections. At B. L. 199.045, the wing was slabbed in a straight line from the 40 percent chord to a trailing edge thickness of 0.200 inches model scale. The tip of the wing was slabbed from the 40 percent chord to a trailing edge thickness of 0.060 inches model scale. The rest of the wing was slabbed from the 40 percent chord to a straight line between these two points on the trailing edge. In addition, the starboard side of each vertical tail was held to contour while the port side was slabbed from the maximum thickness to the trailing edge.

Differences in the four models, which included nose shapes, wing/cuff intersection radii and wing/cuff lower surface fairing, are shown in Figures 1 and 3.

The models were cast around 3/4 inch steel stings coated with R.T.V. using material "G", a proprietary Grumman Aerospace Corp. epoxy. Aluminum noses were installed on each model to prevent excessive ablation and degradation of contour in the nose region.

## DESCRIPTION OF MODEL (CONTINUED)

During the test, modifications were made to two of the models by hand filing the chines and wing/fuselage lower surface intersection and also by filling the void at the wing/cuff lower surface intersection with epoxy.

Additional modifications included the drilling of two holes in the model surface, one on the lower centerline and the other on the side just aft of the nose. These modifications and designated nomenclature are listed in the Configuration Description of this report.

With each batch of material used to cast the orbiter models, a 3 inch diameter material sample hemisphere was cast. Since the models were cast from two batches of material, one for model SS-H-00326-1 and another for models SS-H-00326-2, 3 and 4, sphere number 1 corresponds to the first orbiter model and sphere number 2 corresponds to the next three.

It should be noted, that due to the shrinkage of the model material during casting, the models have been scaled to actually be .00593 scale.

## CONFIGURATION DESCRIPTION

The basic orbiter tested was essentially taken from the Rockwell International 2A Configuration lines. However, due to the nature of this testing, variations to the basic lines were incorporated into these models. Any required geometric data can be obtained from Figures 1, 2 and 3 of this report. Each configuration has been designated by its model drawing number and is listed below with its description.

CONFIGURATION	DESCRIPTION
SS-H-00326-1	Basic 2A Configuration with exceptions as noted on Figures 1, 2, 3 and in Description of Model section of this report.
SS-H-00326-2	Same as above.
SS-H-00326-3	Same as above.
SS-H-00326-4	Same as above.
SS-H-00326-1A	Same as SS-H-00326-1 with cuff/body lower surface intersection filed smooth. Wing/cuff lower surface intersection and cuff/body upper surface fillet radii filled with epoxy. (See Figure 7).
SS-H-00326-4A	Same as SS-H-00326-4 with filing of cuff/body lower surface intersection and chine area forward of cuff. Also, starboard side radius built up with epoxy to be symmetrical with port side. (See Figure 6).
SS-H-00326-4B	Same as SS-H-00326-4A with further filing of cuff/body lower surface intersection. (See Figure 6).

SS-H-00326-4C Same as SS-H-00326-4B with filing of wing/body lower surface intersection in vicinity of  $X/L = 1.0$ . (See Figure 6).

SS-H-00326-4D Same as SS-H-00326-4C with chine area forward of cuff rounded as much as possible in cross-section. (See Figure 6).

SS-H-00326-4E Same as SS-H-00326-4D with further filing of wing/body and cuff/body lower surface intersections. (See Figure 6).

SS-H-00326-4F Same as SS-H-00326-4E with two 0.027 inch deep holes drilled in the model; one .012 inches in diameter on the bottom centerline 0.84 inches aft of the nose, the other 0.18 inches in diameter on the side of the model 0.60 inches aft of the nose and 0.30 inches above the bottom surface.

SS-H-00265-7 Previously fabricated model of preliminary 2A Configuration as tested during test ROX in the NASA/LRC-VDT from January 30 through February 5, 1973. Model had no aluminum nose.

NR 110D Previously tested model of Rockwell International. Phase B design orbiter known to be laminar at 3.0 million Reynolds number per foot.

## DATA REDUCTION

The phase change paint method, as developed by Jones and Hunt (Reference 1), makes use of temperature sensitive paint which changes phase from an opaque solid to a clear liquid at known temperatures. Sudden exposure of the model, thinly coated with this paint, to a hypersonic airstream initiates aerodynamic heating, and melting of the paint ensues as local surface temperatures reach the prescribed phase-change temperature. The propagation of these isotherms was recorded on motion picture film. This information was used in conjunction with the semi-infinite slab solution of the transient one-dimensional heat conduction equation to compute local heat transfer coefficients, which depend on the time required for phase-change to occur, the test conditions and the thermal properties of the model wall material. A reference grid system was applied to one of the test models which was photographed at each test attitude. These grid photos can be used as overlays to simplify data analysis.

Phase change paint data reduction was based on the solution of the transient one-dimensional heat transfer equation:

$$\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial X^2} \quad (\text{Eqn 1})$$

where:  $T$  = temperature  
 $t$  = time  
 $\alpha$  = thermal diffusivity  
 $X$  = distance of heat penetration measured normal to model surface.

The solution to this equation was used to compute local film heat transfer coefficients with the following assumptions which describe the boundary conditions:

(a) The depth of heat penetration into the wall was small compared with the wall thickness and surface radius of curvature so that the wall acted like a semi-infinite slab.

$$T(\infty, t_{\text{sec}}) = T_{\text{in}} \quad (\text{Eqn 2})$$

(b) The model was isothermal before injection into the airstream.

$$T(X, 0) = T_{\text{in}} \quad (\text{Eqn 3})$$

(c) The surface experienced an instantaneous step in aerodynamic heat transfer coefficient and this coefficient was invariant with time.

$$\frac{\partial T(0, t_{\text{sec}})}{\partial X} = \frac{h}{k_w} [T_{\text{AW}} - T(0, t_{\text{sec}})] \quad (\text{Eqn 4})$$

(d) The thermal diffusivity of the wall,  $\alpha = k/\rho C_p$ , was invariant with temperature.

The solution of equation (1) as given in Reference (2) is:

$$\bar{T} = 1 - e^{\beta^2} \operatorname{erfc} \beta \quad (\text{Eqn 5})$$

where  $\bar{T}$  and  $\beta$  are parameters given as:

$$\bar{T} = \frac{T_{PC} - T_{IN}}{T_{AW} - T_{IN}} \quad (\text{Eqn 6})$$

$$\beta = \frac{h \sqrt{t}}{\sqrt{k \rho C_p}} \quad (\text{Eqn 7})$$

and:  $T_{PC}$  = Phase change point temperature ( $^{\circ}\text{F}$ )  
 $T_{IN}$  = Initial model temperature ( $^{\circ}\text{F}$ )  
 $T_{AW}$  = Adiabatic wall temperature ( $^{\circ}\text{F}$ )  
 $h$  = Film heat transfer coefficient ( $\text{Btu}/\text{ft}^2\text{-sec-}^{\circ}\text{F}$ )  
 $t$  = Time (sec)  
 $\rho$  = Density of model material ( $\text{lb}/\text{ft}^3$ )  
 $C_p$  = Specific heat of model material ( $\text{Btu}/\text{lb-}^{\circ}\text{F}$ )  
 $k$  = Thermal conductivity of model material ( $\text{Btu}/\text{ft-sec-}^{\circ}\text{F}$ )

For each test run, the parameter  $\bar{T}$  was calculated by using Equation (6). For every  $\bar{T}$ , a  $\beta$  was determined from Equation (5). Since the thermo-physical properties,  $k$ ,  $\rho$  and  $C_p$  of the model were known and the time required for the phase change to occur was read from the data film, the heat transfer coefficient,  $h$ , was calculated for each isotherm by using Equation (7).

The aerodynamic heating rate,  $\dot{q}$  ( $\text{Btu}/\text{ft}^2\text{-sec}$ ), was then calculated as:

$$\dot{q} = h(T_{AW} - T_W) \quad (\text{Eqn 8})$$

Heat transfer coefficients,  $h$ , were reduced to non-dimensional form as the ratio of  $h/h_s$ , where  $h_s$  is the theoretical heat transfer coefficient at the stagnation point of a 1-foot radius sphere at model scale. This coefficient was determined by first calculating the stagnation point heating rate  $\dot{q}_s$ , given by Fay-Riddell as:

$$\dot{q}_s = \frac{.008575}{\sqrt{N_R}} \left[ \sqrt{\frac{T_{TO}}{T_W}} \frac{T_W + 198.6}{T_{TO} + 198.6} \right]^{0.4}$$

$$\left[ \frac{\rho_\infty T_{TO} \sqrt{T_W}}{T_W + 198.6} \sqrt{\frac{.0028871 P_{TO} - P_\infty}{\rho_\infty}} \right]^{0.5} [H_{TO} - H_W] \quad (\text{Eqn 9})$$

where:  $N_R$  = Nose radius (ft)  
 $T_{TO}$  = Tunnel total temperature ( $^{\circ}\text{F}$ )  
 $T_W$  = Wall temperature ( $^{\circ}\text{F}$ )  
 $\rho_\infty$  = Tunnel static density (lb/ft<sup>3</sup>)  
 $P_{TO}$  = Tunnel total pressure lb/ft<sup>2</sup>)  
 $P_\infty$  = Tunnel static pressure (lb/ft<sup>2</sup>)  
 $H_{TO} - H_W$  = Enthalpy difference between wall and free stream (Btu)

By substituting  $\dot{q}_s$  into Equation (8), we calculated the stagnation point heat transfer coefficient,  $h_s$ .

The data were reduced for the recovery factors listed in Table 1. These recovery factors,  $R_T$ , which are a measure of the fraction of the free stream dynamic temperature rise recovered at the wall, are defined as:

$$R_T = \frac{T_{AW}}{T_{TO}} \quad (\text{Eqn 10})$$

where:  $T_{AW}$  = Adiabatic wall temperature ( $^{\circ}\text{F}$ )  
 $T_{TO}$  = Tunnel total temperature ( $^{\circ}\text{F}$ )

For various tunnel conditions and recovery factors, we solve for  $T_{AW}$  which in turn is substituted into Equations (6) and (8).

## TEST FACILITY DESCRIPTION

The Langley Mach 8 Variable-Density Hypersonic Tunnel is located in Building 1247D and is under the direction of the Aero-Physics Division. This tunnel is used for fundamental aerodynamic and fluid dynamic investigations over large Reynolds number ranges using pressure and heat transfer measurements. The test medium is air and is heated by a combination of Dowtherm and electrical resistance. Model mounting consists of sting mount with injection mechanism. The tunnel has an axially symmetric contoured nozzle. The test section diameter is 18 inches with a core of 4 to 14 inches depending on pressure. It exhausts into a vacuum tank or the atmosphere.

Examples of operating conditions are as follows:

Stagnation pressure (PSIA) . . . . . 15 to 2930

Stagnation temperature ( $^{\circ}$ R) . . . . . 1160 to 1510

Mach Number . . . . . 7.5 to 8.0

Reynolds number per foot (1/ft) . . .  $0.1 \times 10^6$  to  $12.0 \times 10^6$

Running time (SEC), for

Exhausting into vacuum tank 90

Exhausting into atmosphere 600



## PHASE CHANGE PAINT DATA

The test results are shown in Figures 20 through 158 in the form of heating contours. These contours are correlated to heat transfer coefficient ratios ( $h/h_g$ ), the ratio of local heat transfer coefficient on the model surface to the heat transfer coefficient at the stagnation point of a one-foot radius sphere at model scale. A list of the tunnel conditions for each run is presented as Table 3 in the order in which they were made.

TABLE 1: DATA REDUCTION RECOVERY FACTORS

ANGLE OF ATTACK, $\alpha$ (DEG)	RECOVERY FACTOR, $T_{AW}/T_{TO}$	
	WINDWARD VIEW	TOP AND PROFILE VIEW
-5	---	<div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 10px;">.900</div> <div style="text-align: center;"> <div style="width: 1px; height: 50px; background-color: black; margin: 0 auto;"></div> <div style="font-size: 8px; margin-top: 2px;">↓</div> </div> </div>
0	---	
25	.898	
30	.910	
35	.920	

TABLE 2: MODEL MATERIAL PROPERTIES,  $\sqrt{k \rho C_p}$

VALUES OF  $\sqrt{k \rho C_p}$ , (BTU/FT<sup>2</sup> - SEC<sup>0.5</sup> - °F)

T <sub>PC</sub> (°F)	(1)	(2)
119	—	.0498
150	—	.0506
182	.0519	—
213	.0525	.0520
250	—	.0529
300	.0546	.0538
325	—	.0541
350	—	.0544
400	.0570	.0548

- (1) Applied to windward data acquired for runs 3778 through 3793 and 3798 through 3804 and profile data acquired for runs 3778 through 3792.
- (2) Applied to windward and leeward data acquired for runs 3805 through 3849 and profile data for runs 3793 through 3842.

Note: Windward data acquired for runs 3794 through 3797 were reduced using a constant value for  $\sqrt{k \rho C_p}$  of .0900.

TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDTTEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	$\frac{T_{aw}}{T_{total}}$	RNX10 <sup>6</sup> Ft	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									$\alpha$	$\theta$	$\phi$	X	Y	Z
3778	SS-H-00326-1	0.006	7.9	639.7	1375	***	2.93	300	30	0	180			
3779	-2			649.7	1340		3.10	300						
3780	-3			644.7	1335		3.10	300						
3781	-4			634.7	1325		3.09	300						
3782	SS-H-00265-7			644.7	1375		2.95	300						
3783	SS-H-00326-1			649.7	1365		3.01	400						
3784	SS-H-00265-7			649.7	1325		3.16	400						
3785	SS-H-00326-2			174.7	1295		0.93	213						
3786	-3			639.7	1380		2.91	213						
3787	-4			174.7	1260		0.98	182						
3788	-2			639.7	1385		2.89	213						
3789	-3			177.7	1285		0.96	182						
3790	-4			649.7	1385		2.94	213						

\*\* X axis parallel to stream (+downstream, -upstream)

Y axis (+right, -left, as viewed from the rear)

Z axis (+up, -down)

\*  $T_{aw}$  = adiabatic wall temperature

\*\*\* See Table 1

TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDT

TEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	T <sub>aw</sub> * T <sub>total</sub>	RNX10 <sup>6</sup> Ft	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									α	β	φ	X	Y	Z
3791	SS-H-00326-2	0.006	7.9	174.7	1275	***	0.96	182	30	0	180			
3792	-3			1394.7	1405		5.98	400						
3793	-4			1424.7	1410		6.07	400						
3794	NR 110 D			634.7	1385		2.87	150	35					
3795	NR 110 D			664.7	1390		2.98	213						
3796	NR 110 D			639.7	1390		2.89	250						
3797	NR 110 D			644.7	1390		2.90	150	30					
3798	SS-H-00326-3			544.7	1360		2.56	213						
3799	-2			464.7	1340		2.25	213						
3800	-3			464.7	1365		2.18	213						
3801	-2			VOID	RUN		--	213						
3802	-2			539.7	1345		2.58	213						
3803	-3			429.7	1340		2.09	213						

\*\* X axis parallel to stream (+downstream, -upstream)

Y axis (+right, -left, as viewed from the rear)

Z axis (+up, -down)

\* T<sub>aw</sub> = adiabatic wall temperature

\*\*\* See Table 1

TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDTTEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	$\frac{T_{aw}}{T_{total}}$	$\frac{RNX10^6}{Ft}$	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									$\alpha$	$\theta$	$\phi$	X	Y	Z
3804	SS-H-00326-2	0.006	7.9	424.7	1380	***	1.96	213	30	0	180			
3805	-3			794.7	1420		3.42	213						
3806	-2			774.7	1360		3.58	213						
3807	-3			774.7	1390		3.46	300						
3808	-4A			639.7	1360		2.98	300						
3809	-4A			639.7	1395		2.86	350						
3810	-4B			639.7	1365		2.96	350						
3811	-4C			639.7	1345		3.04	300						
3812	-4C			174.7	1275		0.96	150						
3813	-4C			1039.7	1425		4.40	400						
3814	-4C			1064.7	1405		4.61	350						
3815	-4D			1064.7	1370		4.81	350						
3816	-4D			664.7	1385		3.00	250						

\*\* X axis parallel to stream (+downstream, -upstream)  
 Y axis (+right, -left, as viewed from the rear)  
 Z axis (+up, -down)

\*  $T_{aw}$  = adiabatic wall temperature

\*\*\* See Table 1

TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDTTEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	$\frac{T_{aw}}{T_{total}}$	$\frac{RNX10^6}{Ft}$	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									$\alpha$	$\beta$	$\phi$	X	Y	Z
3817	SS-H-00326-4D	0.006	7.9	639.7	1345	***	3.04	300	30	0	180			
3818	-4E			639.7	1320		3.13	350						
3819	-4E			649.7	1340		3.10	300						
3820	-4E			664.7	1335		3.19	325						
3821	-4E			1099.7	1405		4.76	350						
3822	-4E			1414.7	1375		6.29	400						
3823	-4E			179.7	1225		1.05	150						
3824	-1A			639.7	1330		3.09	300						
3825	-1A			1424.7	1375		6.33	400						
3826	-1A			179.7	1245		1.02	150						
3827	-1A			647.9	1310		3.22	250	25					
3828	-4E			649.7	1310		3.22	250						
3829	-1A			1394.7	1345		6.44	350						

\*\* X axis parallel to stream (+downstream, -upstream)  
 Y axis (+right, -left, as viewed from the rear)  
 Z axis (+up, -down)

\*  $T_{aw}$  = adiabatic wall temperature

\*\*\* See Table 1

TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDTTEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	$\frac{T_{aw}}{T_{total}}$	RNX10 <sup>6</sup> Ft	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									$\alpha$	$\theta$	$\phi$	X	Y	Z
3830	SS-H-00326-4E	0.006	7.9	1394.7	1395	***	6.06	350	25	0	180			
3831	-1A			VOID	RUN		--							
3832	-1A			174.7	1250		0.99	150						
3833	-4E			174.7	1235		1.01	150						
3834	-1A			664.7	1320		3.25	300	35					
3835	-4E			639.7	1360		2.98	300						
3836	-1A			174.7	1355		0.87	150						
3837	-4E			174.7	1310		0.92	150						
3838	-1A			1394.7	1360		6.32	400						
3839	-4E			1424.7	1355		6.50	400						
3840	-4F			684.7	1330		3.30	300	30					
3841	-4F			664.7	1330		3.21	213						
3842	-4F			1064.7	1410		4.59	350						

\*\* X axis parallel to stream (+downstream, -upstream)  
 Y axis (+right, -left, as viewed from the rear)  
 Z axis (+up, -down)

\*  $T_{aw}$  = adiabatic wall temperature

\*\*\* See Table 1



TABLE 3

## PHASE CHANGE COATING TEST DATA SUMMARY SHEET

TEST TITLE: \_\_\_\_\_

TEST NUMBER: RP 3 TEST FACILITY: NASA/LRC - VDT

TEST DATE: March 19-28, 1973 TEST ENGINEER: A. D'Errico

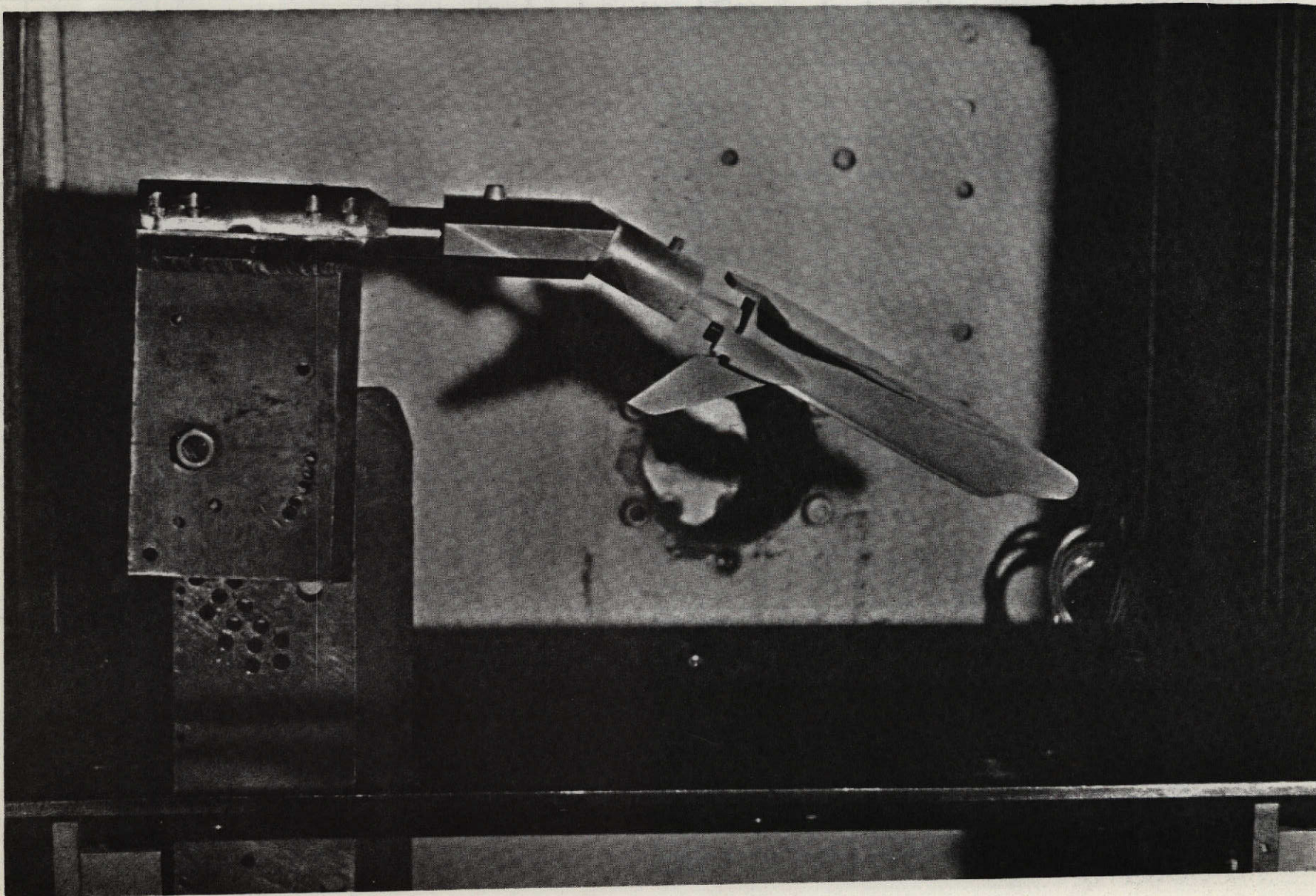
Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	T <sub>aw</sub> * T <sub>total</sub>	RNX10 <sup>6</sup> Ft	Phase Change Temp. (°F)	Model Position (degrees)			Camera** Location (in)		
									$\alpha$	$\theta$	$\phi$	X	Y	Z
3843	SS-H-00326-4F	0.006	7.9	1424.7	1340	***	6.61	400	30	0	180			
3844	-3			634.7	1275		3.30	150	-5		0			
3845	-3			1414.7	1410		6.03	300						
3846	-3			174.7	1210		1.05	119						
3847	-3			644.7	1335		3.10	150	0					
3848	-3			1414.7	1340		6.57	300						
3849	-3			174.7	1235		1.01	119						
3850	3" dia hemisphere (from previous test box)	FULL		639.7	1360		2.98	300						
3851				174.7	1260		0.98	150						
3852				639.7	1340		3.06	400						
3853	3" dia hemisphere (#2)			644.7	1345		3.06	300						
3854				179.7	1250		1.01	150						
3855				639.7	1340		3.06	400						

\*\* X axis parallel to stream (+downstream, -upstream)  
 Y axis (+ right, - left, as viewed from the rear)  
 Z axis (+up, -down)

\* T<sub>aw</sub> = adiabatic wall temperature

\*\*\* See Table 1

PHOTO 1: TYPICAL INSTALLATION OF MODELS 33-0 IN THE NASA/LRC-VARIABLE DENSITY TUNNEL





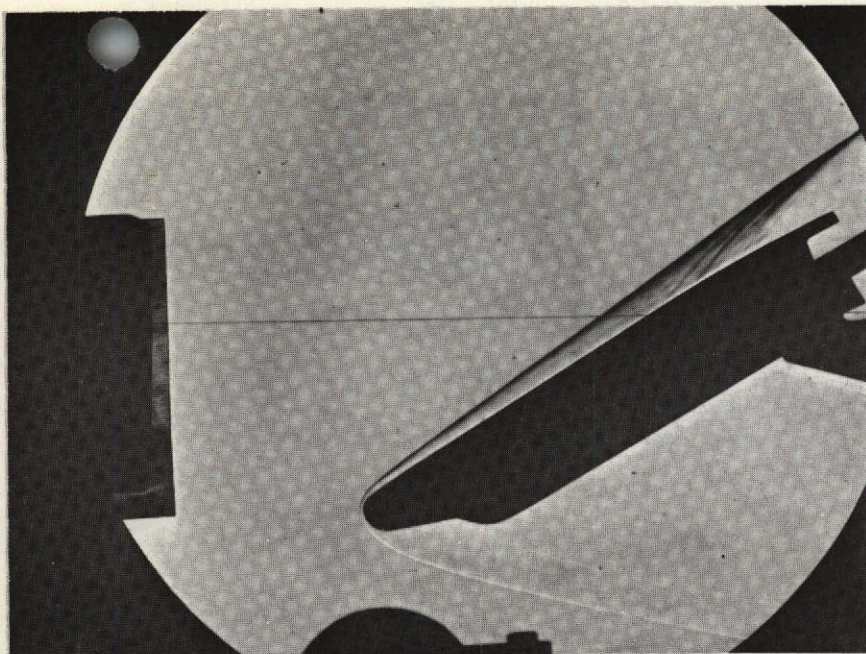


PHOTO 2: RUN 3824, MODEL SS-H-00326-1A  
 $\alpha = 30^\circ$ ,  $Re/Ft = 3.09 \times 10^6$

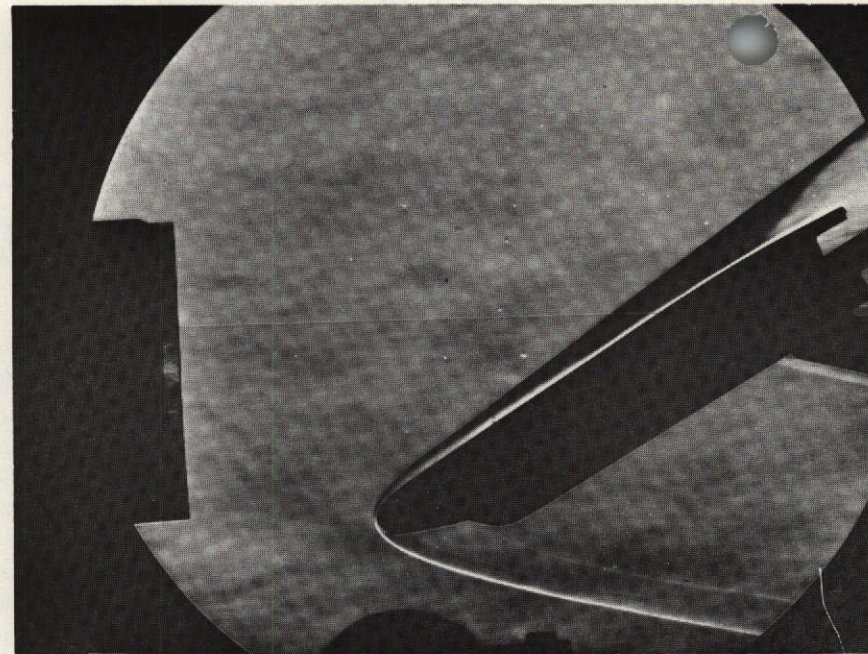


PHOTO 3: RUN 3788, MODEL SS-H-00326-2  
 $\alpha = 30^\circ$ ,  $Re/Ft = 2.89 \times 10^6$

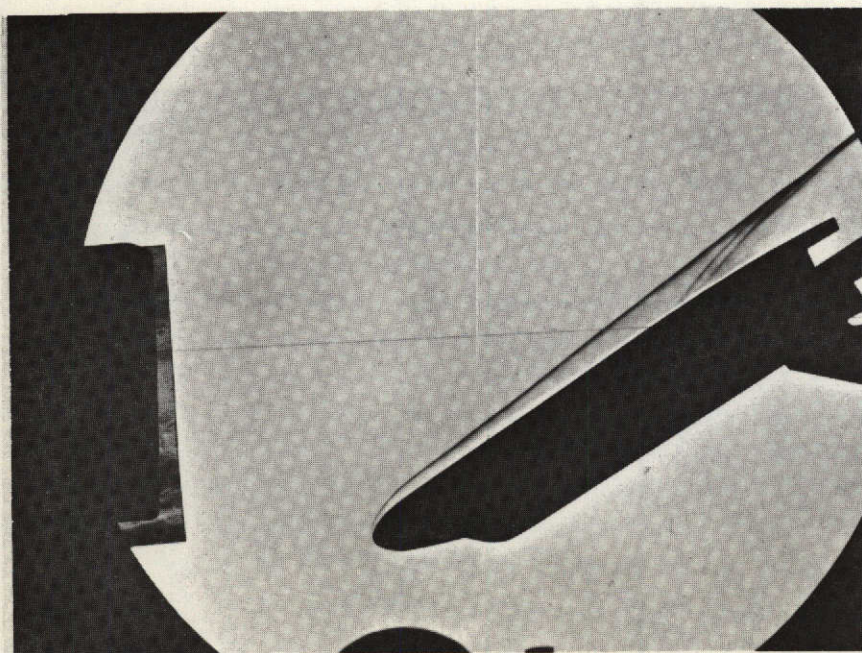


PHOTO 4: RUN 3780, MODEL SS-H-00326-3  
 $\alpha = 30^\circ$ ,  $Re/Ft = 3.10 \times 10^6$

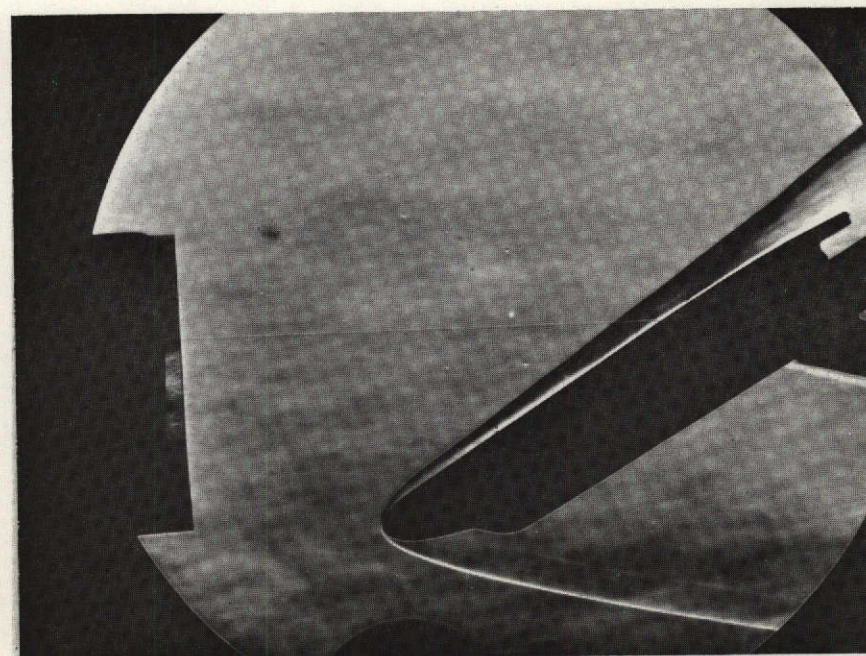


PHOTO 5: RUN 3790, MODEL SS-H-00326-4  
 $\alpha = 30^\circ$ ,  $Re/Ft = 2.94 \times 10^6$



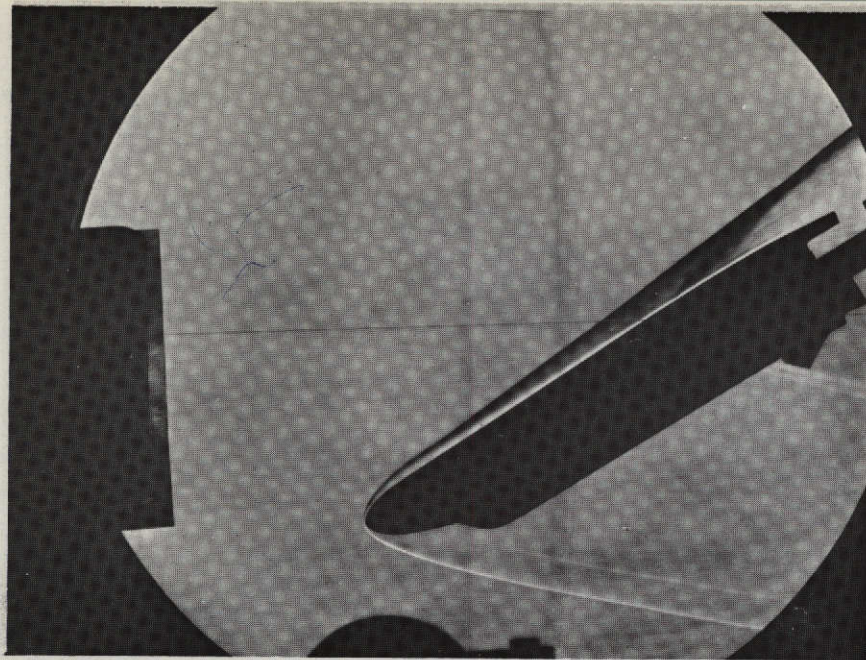


PHOTO 6: RUN 3820, MODEL SS-H-00326-4E  
 $\alpha = 30^\circ$ ,  $Re/Ft = 3.19 \times 10^6$

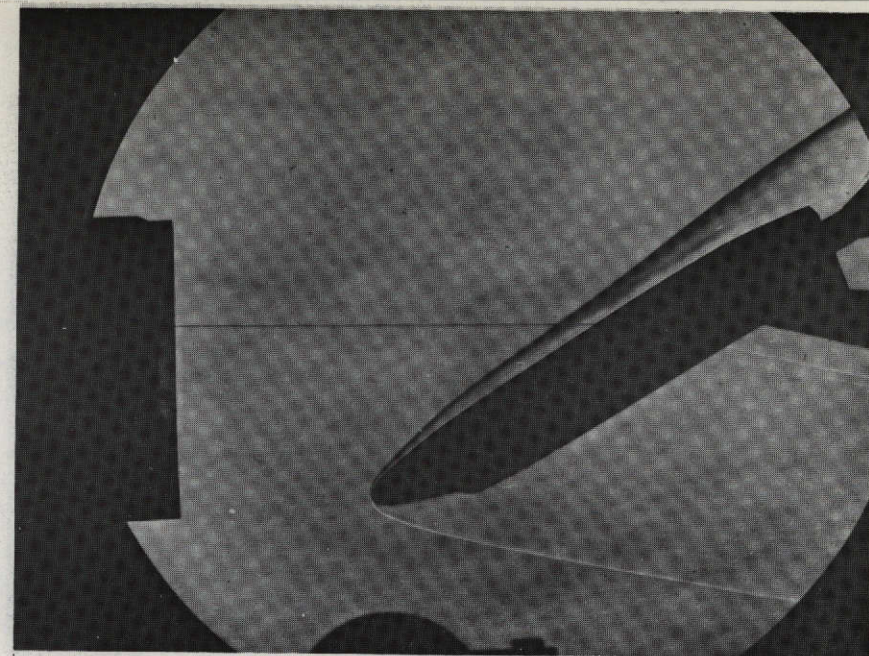


PHOTO 7: RUN 3797, MODEL NR 110 D  
 $\alpha = 30^\circ$ ,  $Re/Ft = 2.90 \times 10^6$

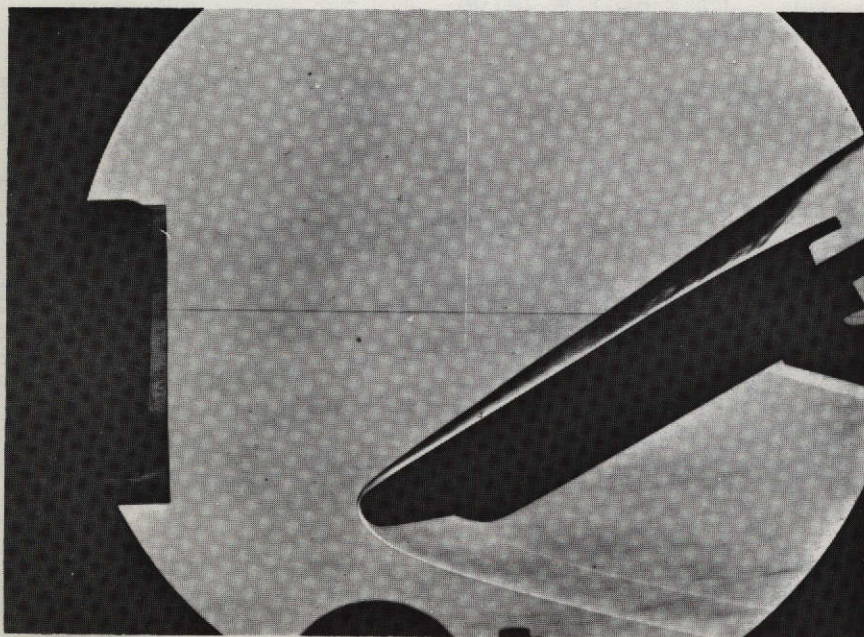


PHOTO 8: RUN 3825, MODEL SS-H-00326-1A  
 $\alpha = 30^\circ$ ,  $Re/Ft = 6.33 \times 10^6$

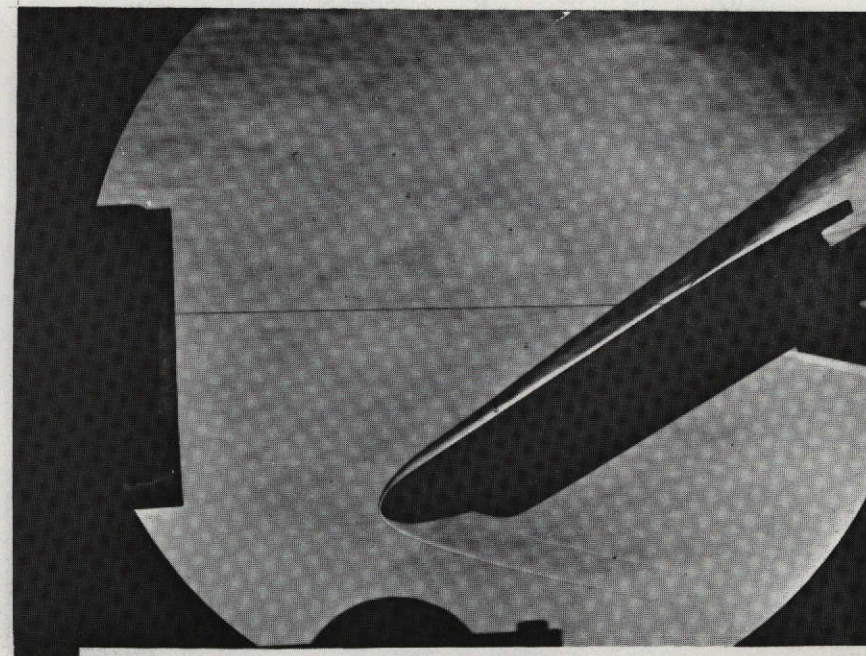


PHOTO 9: RUN 3793, MODEL SS-H-00326  
 $\alpha = 30^\circ$ ,  $Re/Ft = 6.07 \times 10^6$



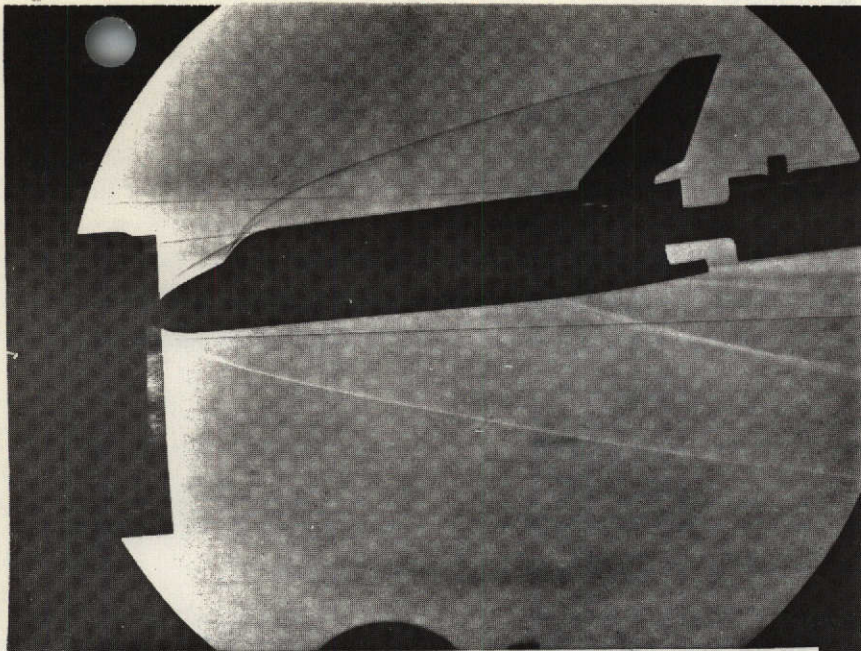


PHOTO 10: RUN 3846, MODEL SS-H-00326-3  
 $\alpha = -5^\circ$ ,  $Re/Ft = 1.05 \times 10^6$

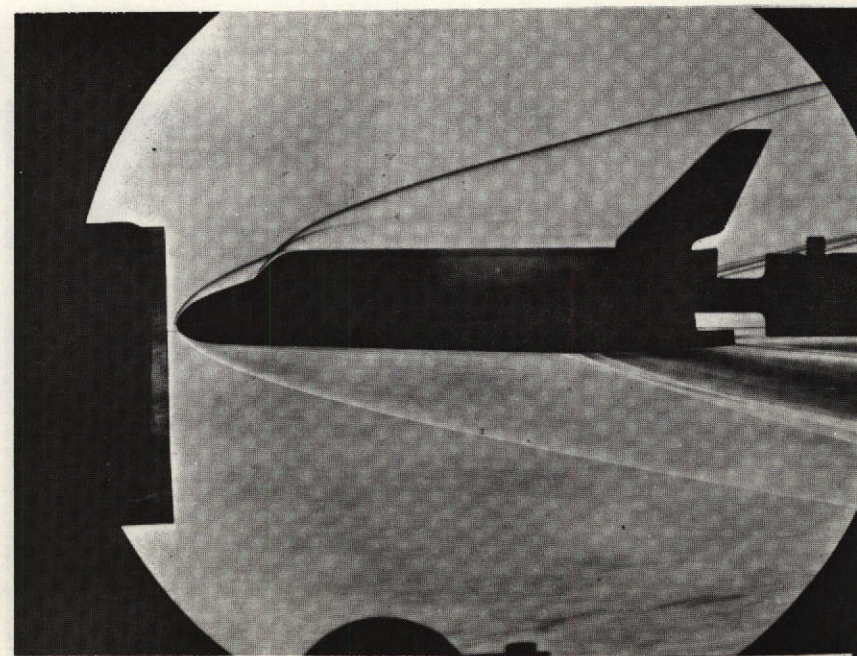


PHOTO 11: RUN 3848, MODEL SS-H-00326-3  
 $\alpha = 0^\circ$ ,  $Re/Ft = 6.57 \times 10^6$



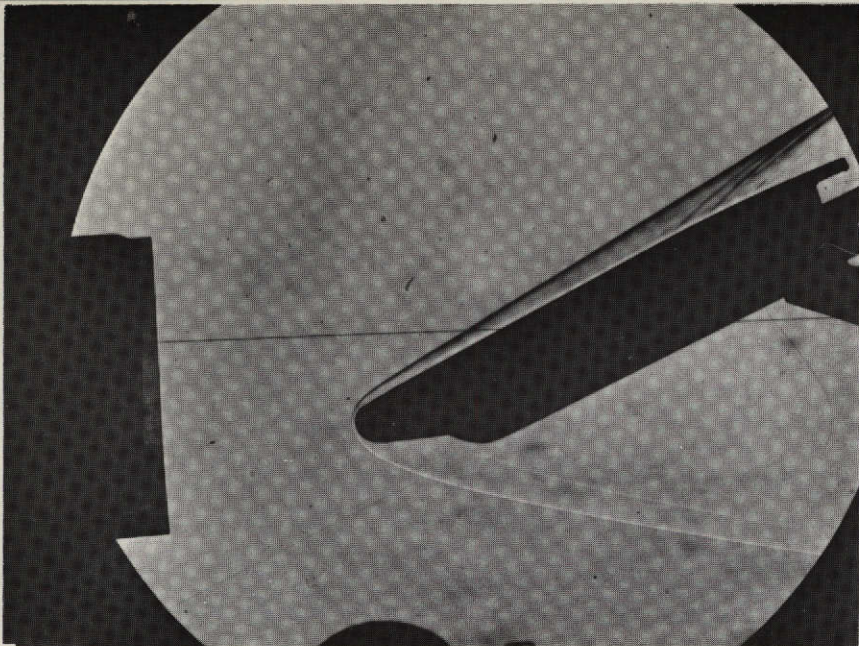


PHOTO 12: RUN 3827, MODEL SS-H-00326-1A  
 $\alpha = 25^\circ$ ,  $Re/Ft = 3.22 \times 10^6$

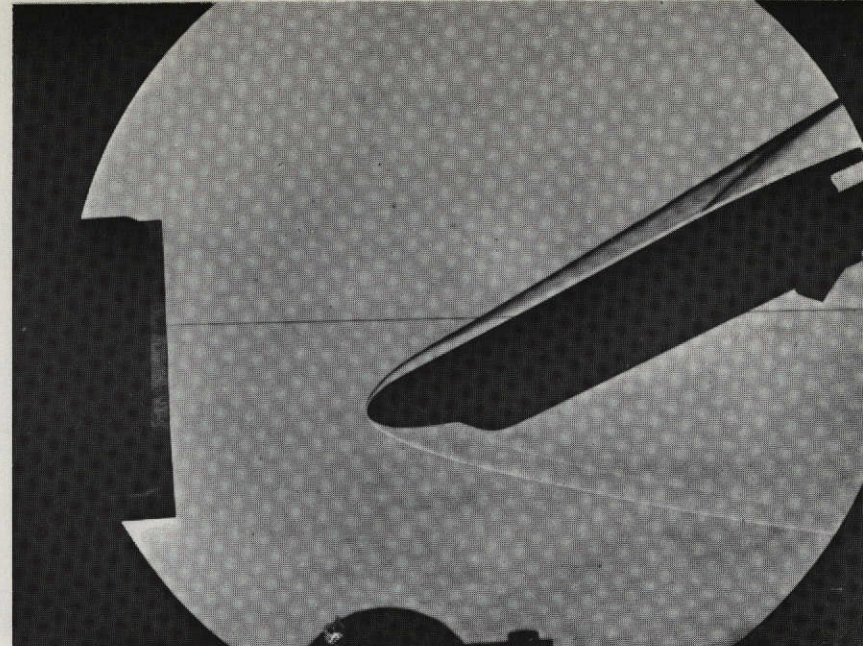


PHOTO 13: RUN 3828, MODEL SS-H-00326-4E  
 $\alpha = 25^\circ$ ,  $Re/Ft = 3.22 \times 10^6$

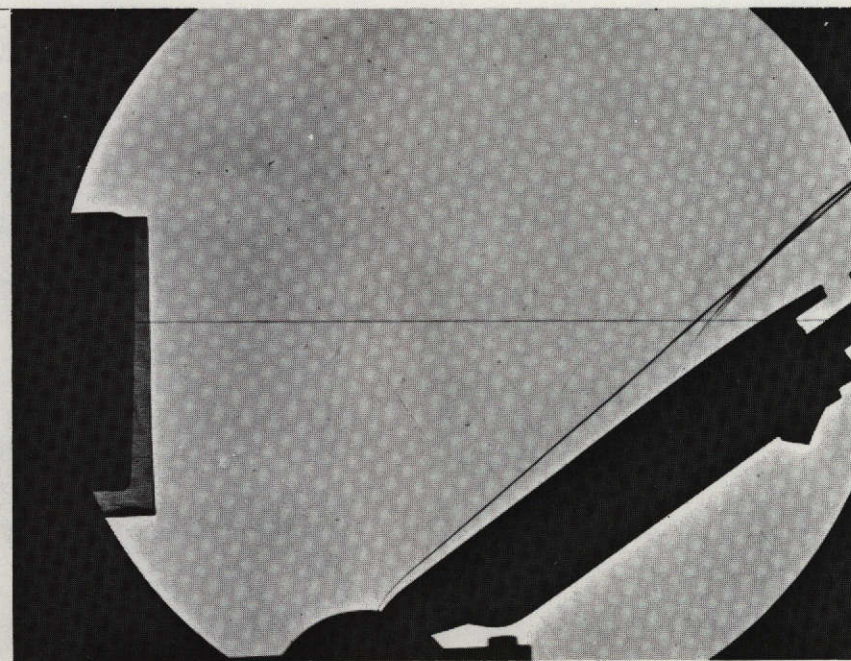


PHOTO 14: RUN 3839, MODEL SS-H-00326-4E  
 $\alpha = 35^\circ$ ,  $Re/Ft = 6.50 \times 10^6$



SS-H-Q0326-12 BODY  
FOR - 4 MODEL

SS-H-00926-12  
SAME AS -11 EXCEPT AS SHOWN  
VIEW A-A (BOTTOM)

CURVE TAKEN FROM TEMP.  
VL 70-006041 (3.15R APX)

~~SECRET~~ Y. 19. 25Z  
+1 INCIDENCE

SS-H-00326 -15 NOSE FOR -3 MODEL  
-14 NOSE FOR -2  
-13 NOSE FOR -1

SS-H-00326-1, 2 & 3

SS-H-30326-11 BODY FOR -1,-2,-3 MODELS-

53-N-00326-11  
AS PER VL70-000093  
VIEW A-A (BOTTOM)

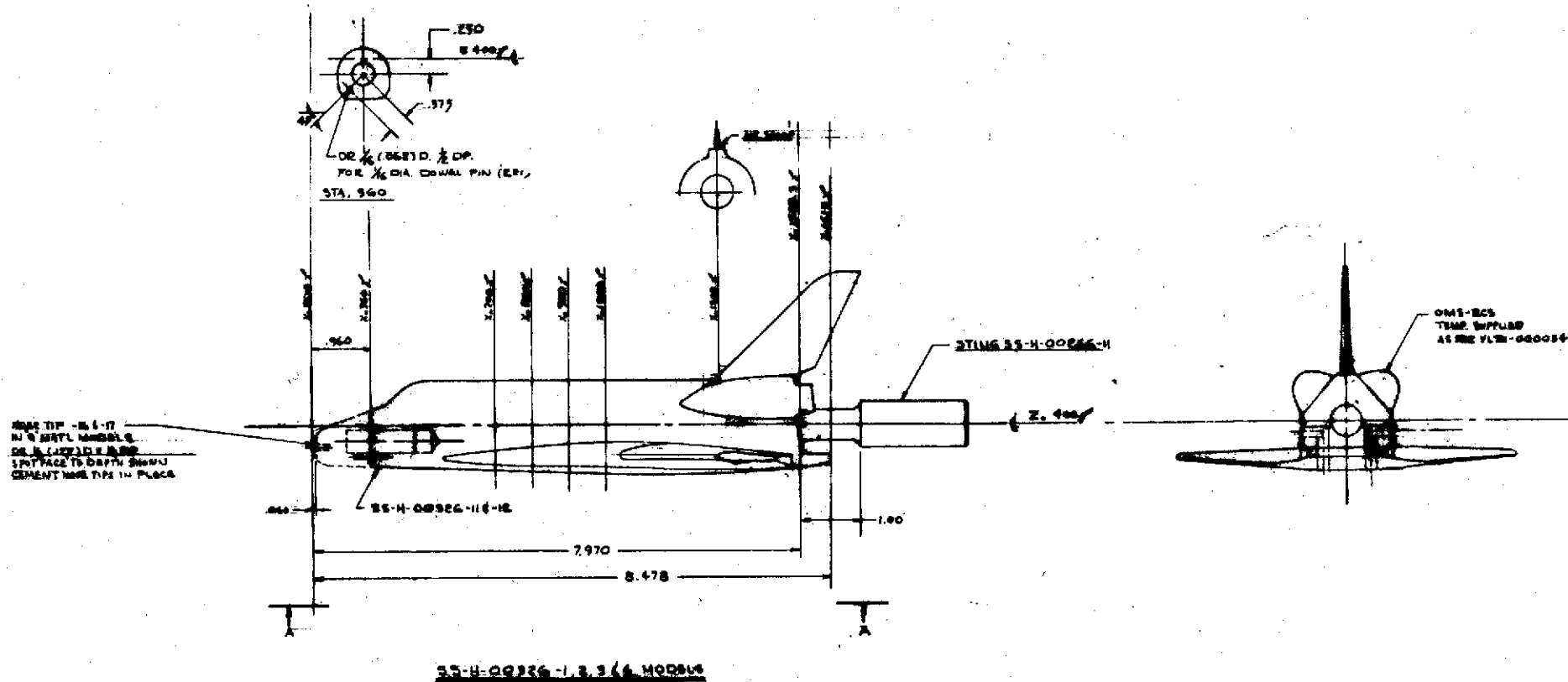
OML 33-H-00265 (RBF)  
AS PER VL70-00089  
44 FWD

TEMPLATES REQD.  
1170-00000 TEMPLATES 0

TEMPLATES USED:  
VL70-000093 T  
VL70-000041 W

FIGURE 1 ORBITER CONFIGURATION (WINDWARD VIEW)

# FIGURE 2 ORBITER CONFIGURATION (PROFILE VIEW)

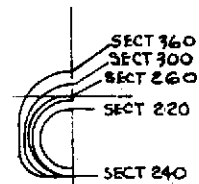
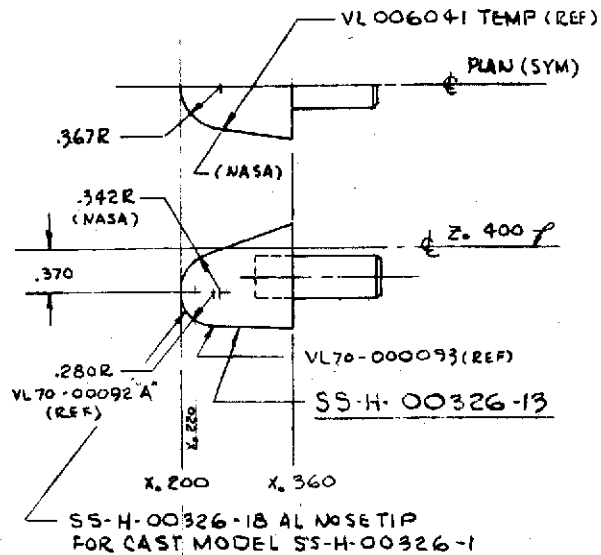


## GENERAL NOTES:

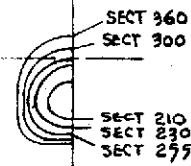
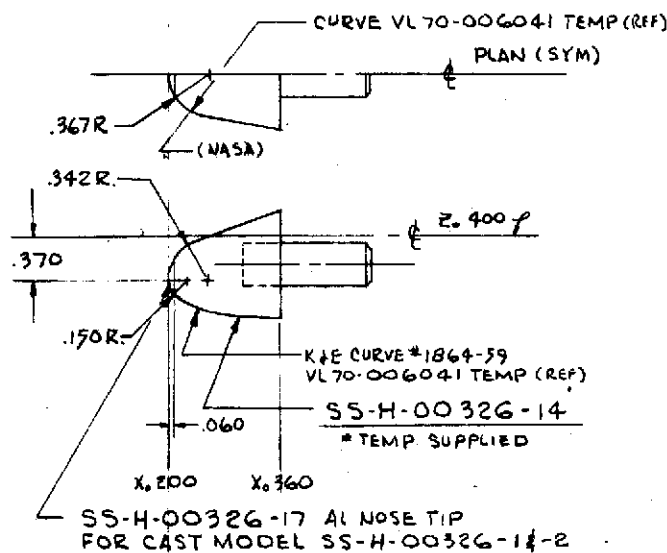
1. ORBITER CONFIGURATION IS PER VLN-000034, VLN-000092A & VLN-000092B - MOD 01 SECTION
2. ALL DIMENSIONS ARE UNLESS OTHERWISE SPECIFIED AS PER DWG. SS-H-00266-11 REV. 1, 7-1-8
3. MATERIALS TO BE USED AS SHOWN ON DRAWING UNLESS OTHERWISE SPECIFIED AS PER DWG. SS-H-00266-11 REV. 1, 7-1-8
4. ORBITER STING - 11 IN REV. 1, 7-1-8 TO CURVE PRIOR TO CASTING IN PLACE



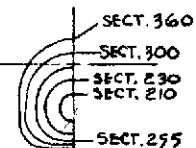
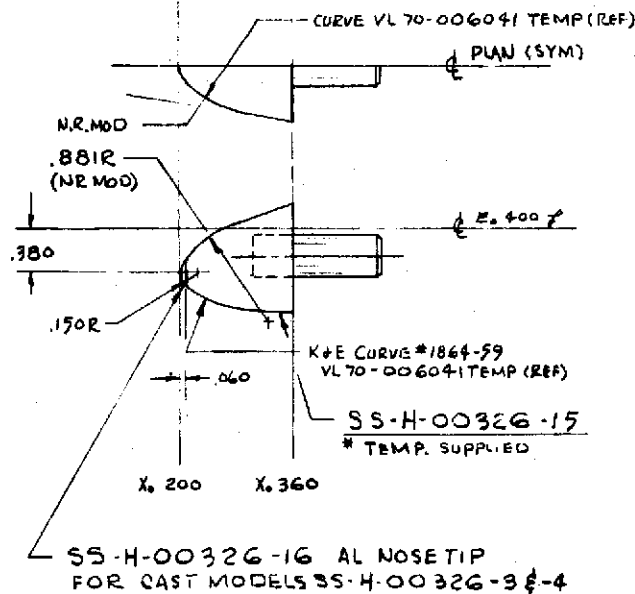
# FIGURE 3 ORBITER NOSES



TEMP. FOR STATIONS  
TAKEN FROM VL70-000092A



TEMP. FOR STATIONS  
TAKEN FROM VL70-006041



TEMPLATES FOR STATIONS  
TAKEN FROM VL70-006041

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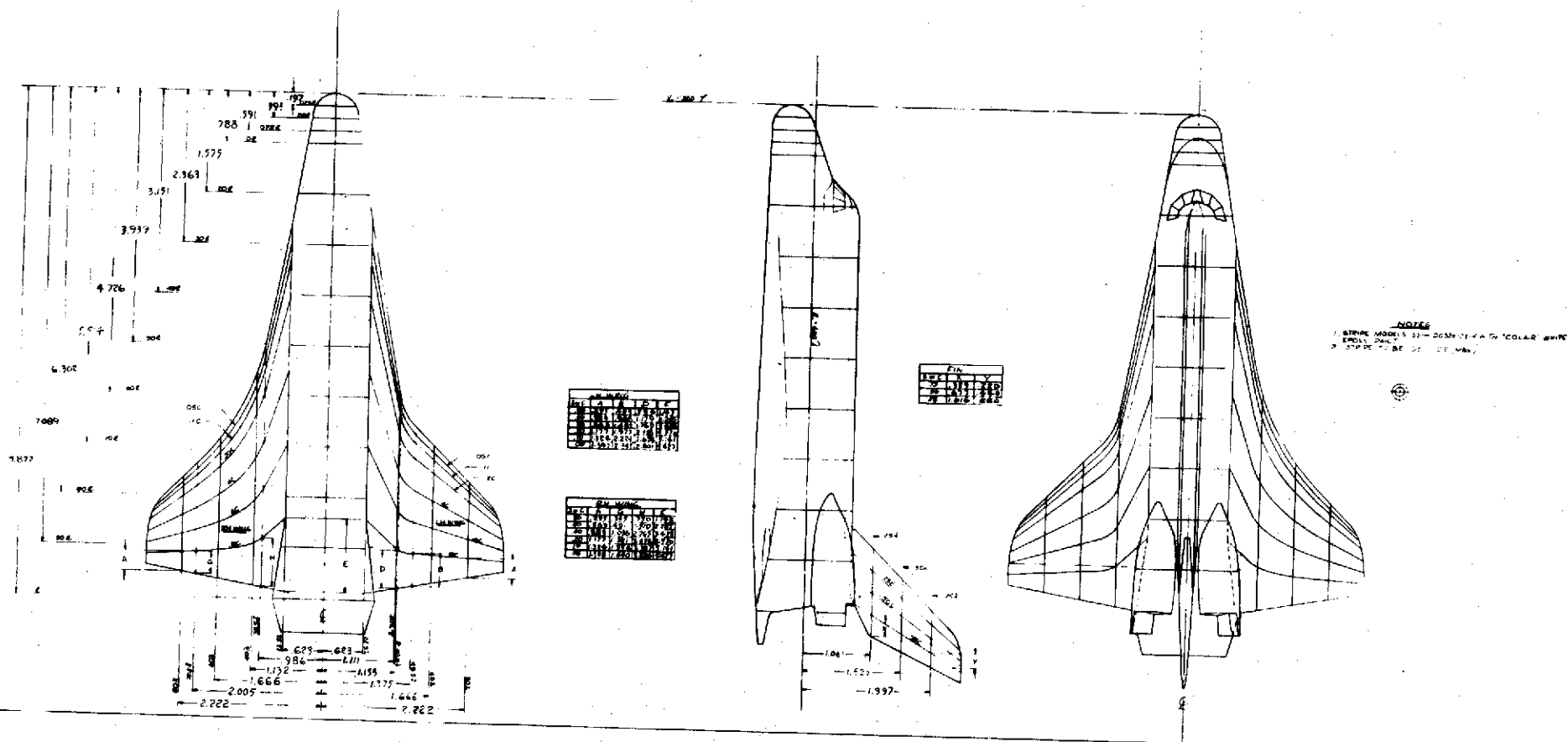


FIGURE 5 3" DIA. HEMISPHERE GRID SYSTEM

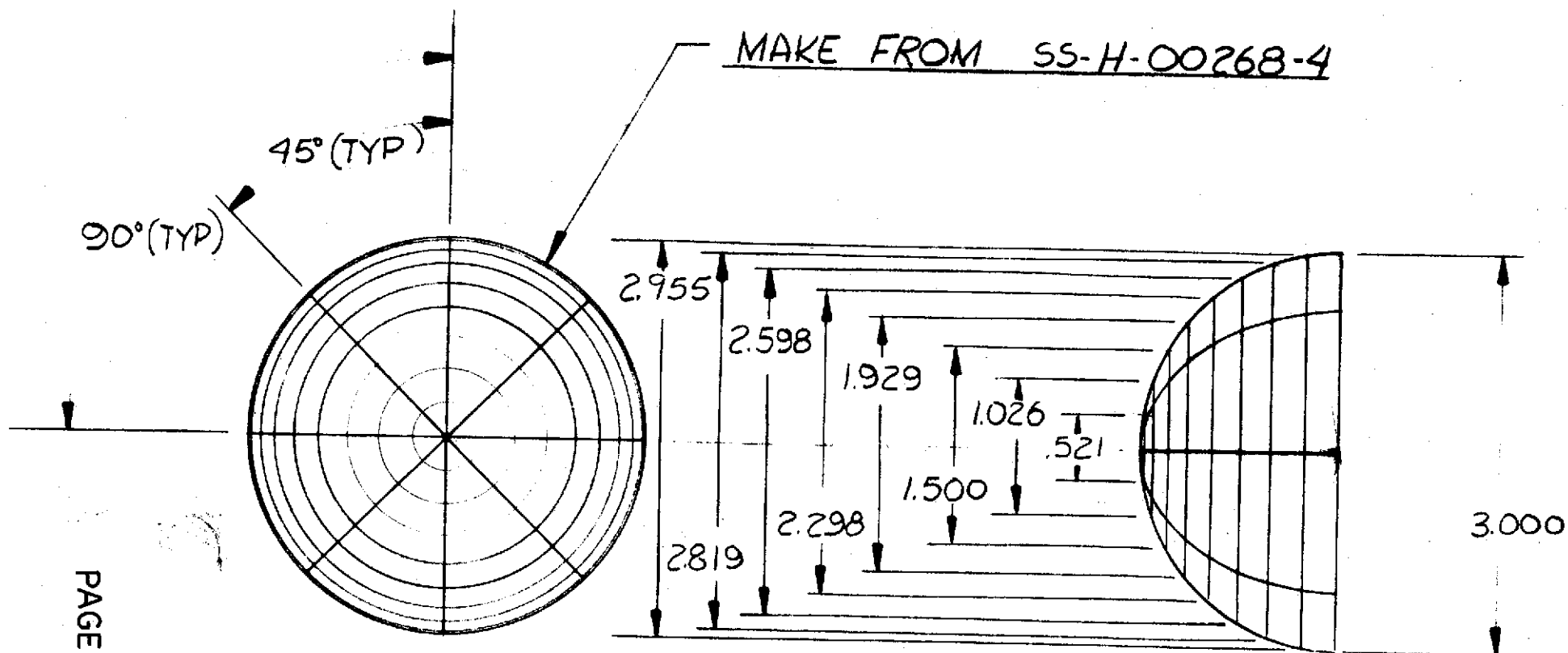


FIGURE 6 MODIFICATIONS TO MODEL SS-H-00326-4

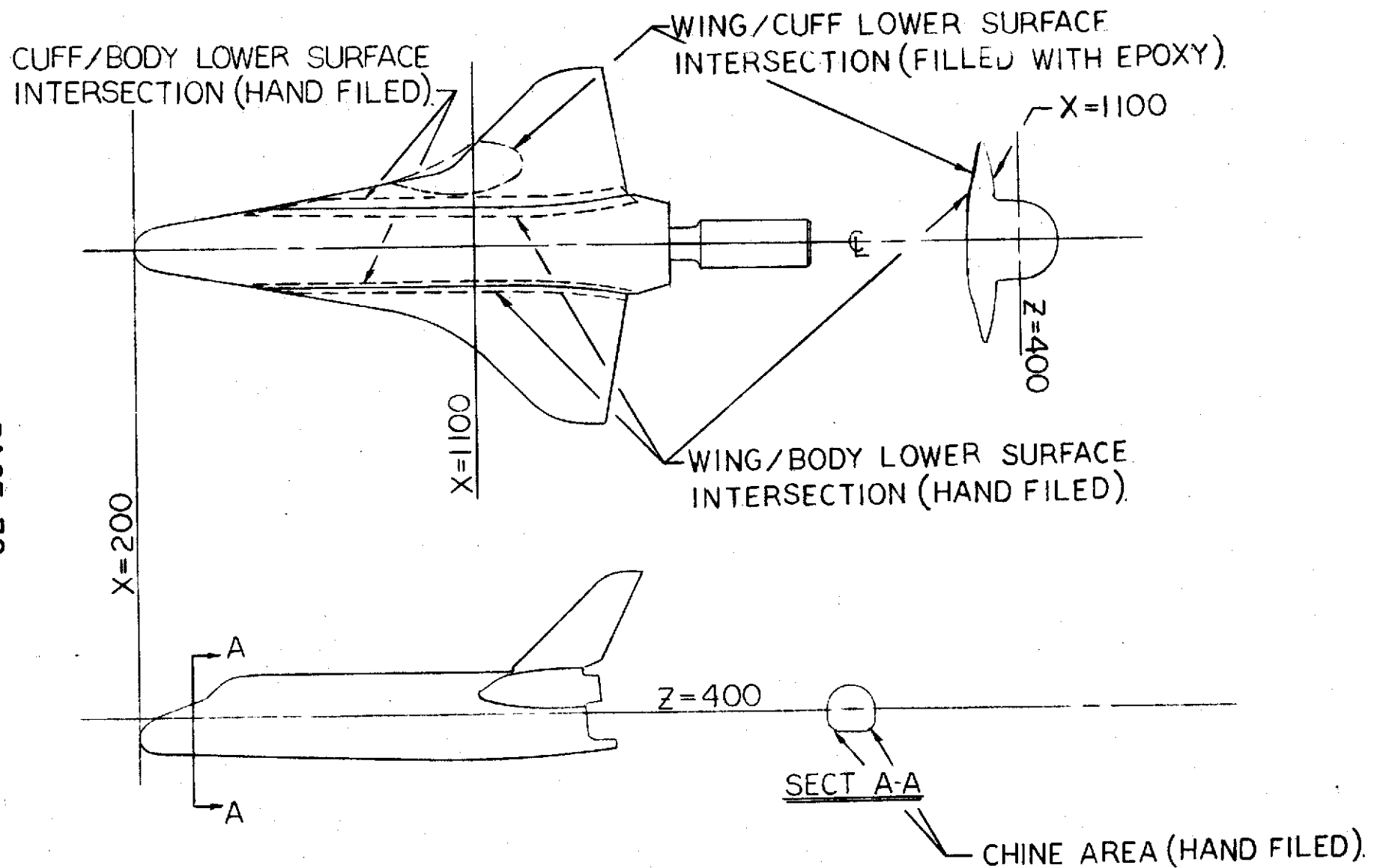
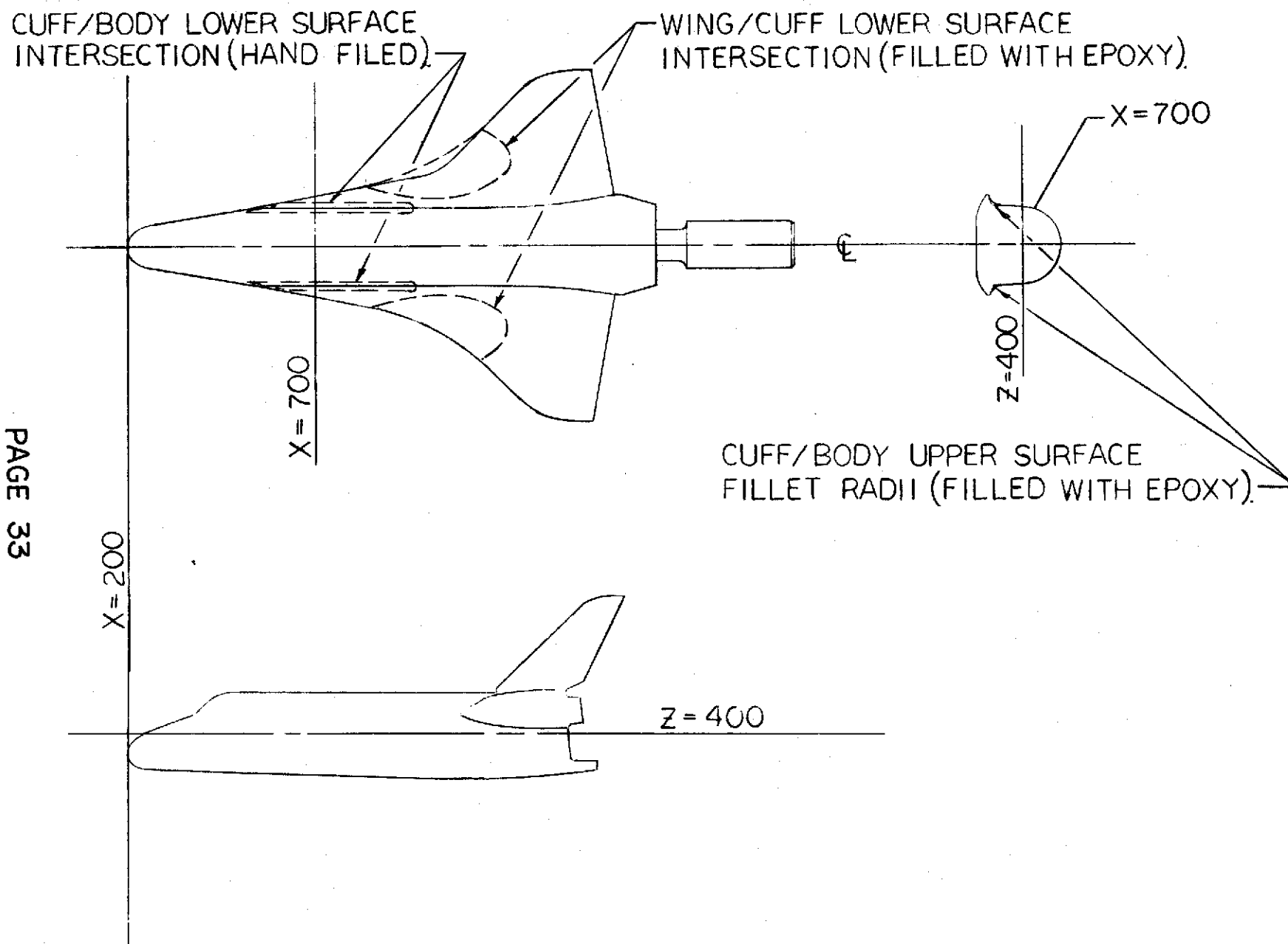
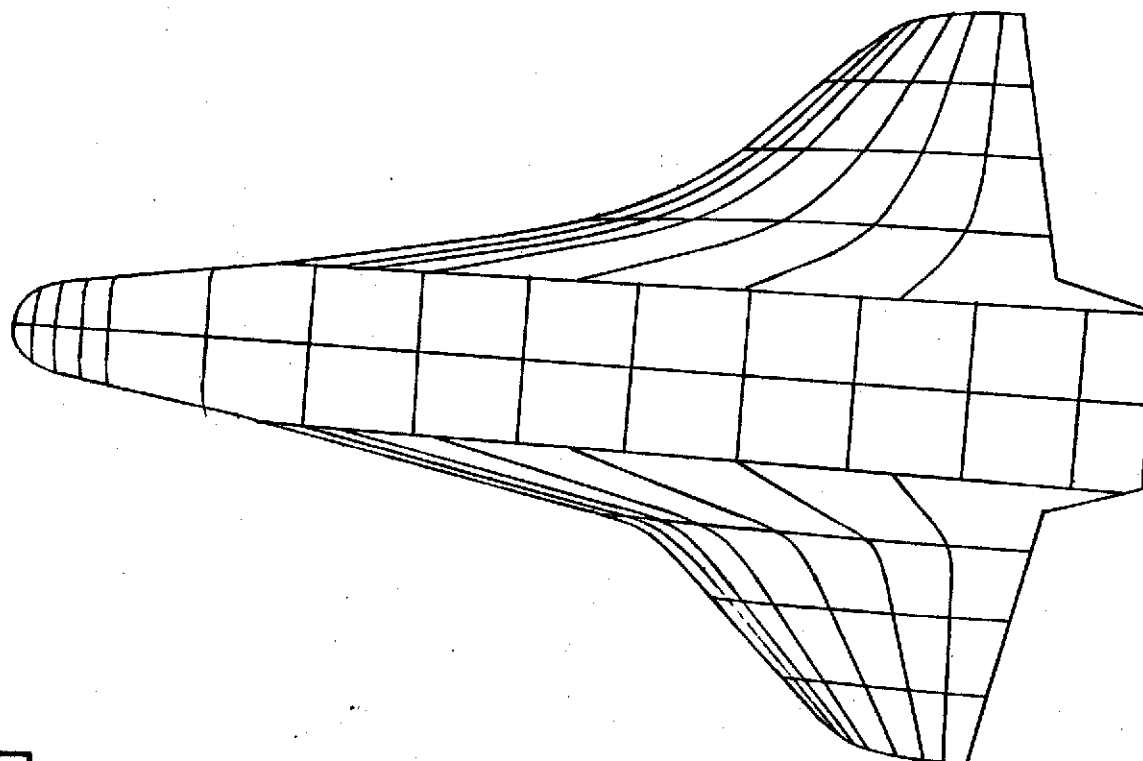


FIGURE 7 MODIFICATIONS TO MODEL SS-H-00326-1



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 8

CONFIG.

SS-H-00326-2

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}$ R) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) =

$\alpha$  = 25

$\beta$  = 0

$\phi$  = 180

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

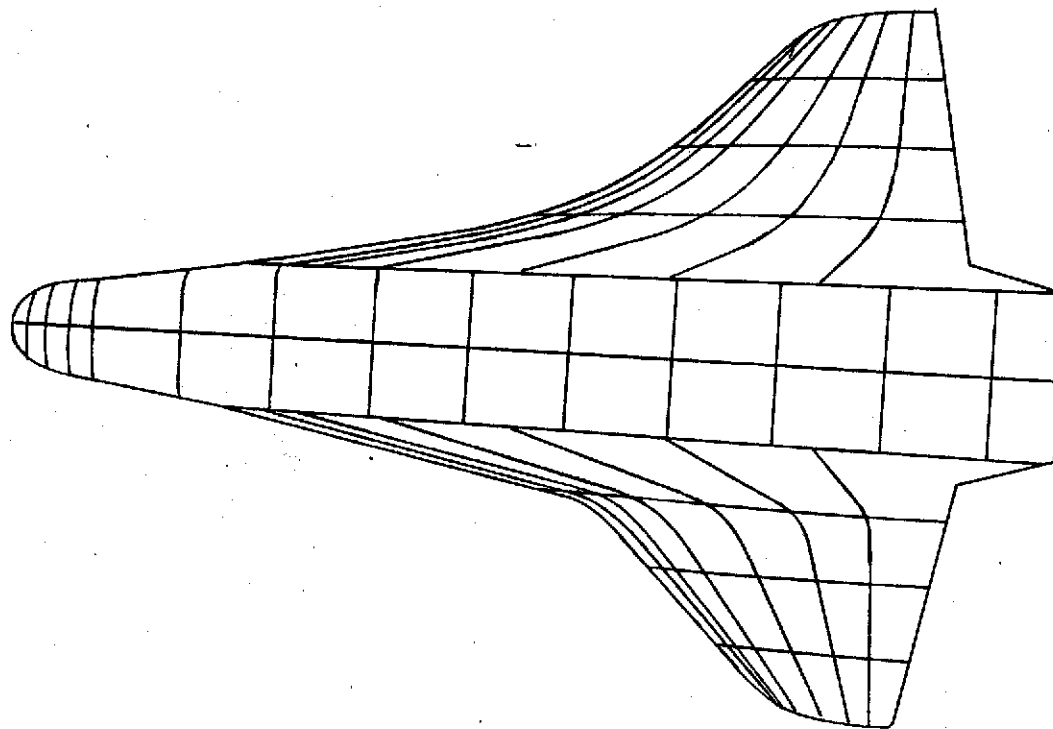
x (in) =

y (in) =

z (in) =

HVD-EVC

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 9

CONFIG.

SS-H-00326-2

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha = 30$

$\beta = 0$

$\phi = 180$

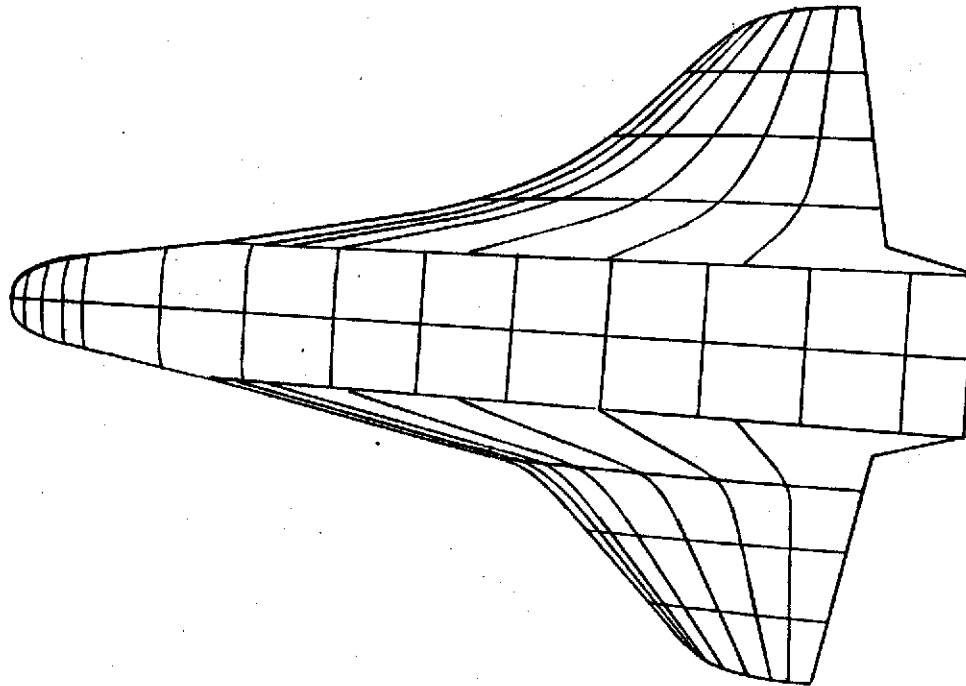
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1'}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 36

FIGURE 10

CONFIG.

SS-H-00326-2

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha = 35$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

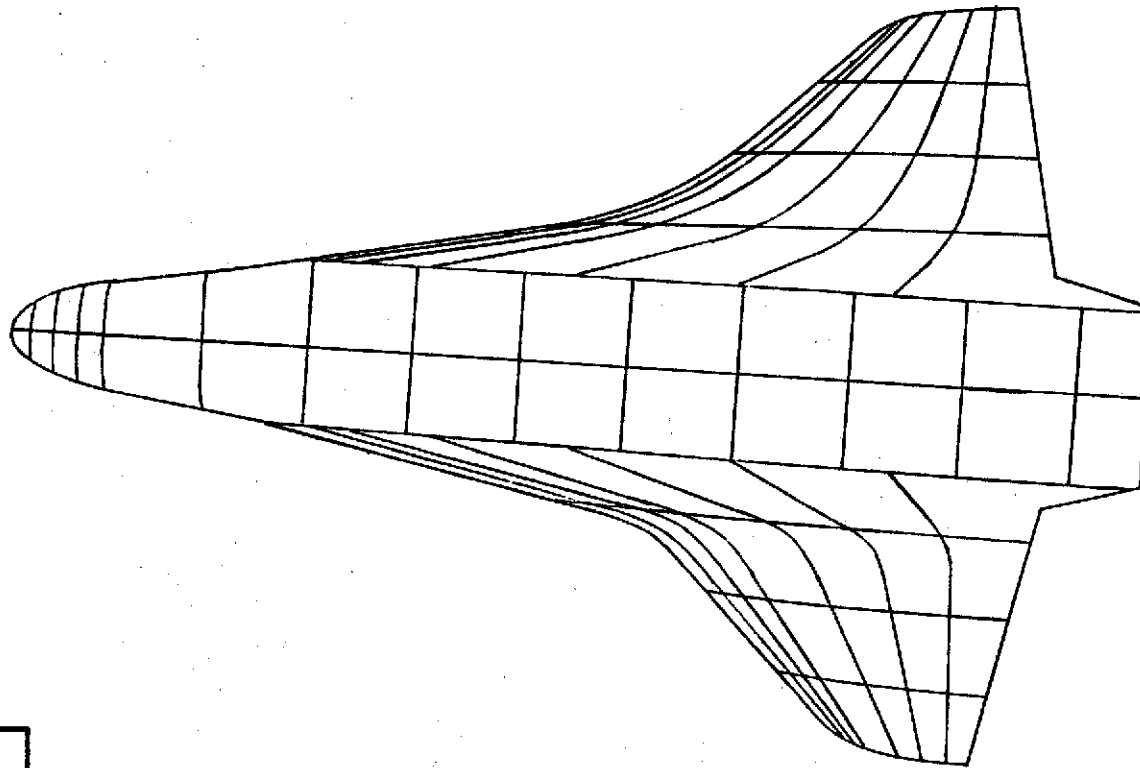
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1'}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 37  
FIGURE 11

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_{\infty}$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha$  = 25

$\beta$  = 0

$\phi$  = 180

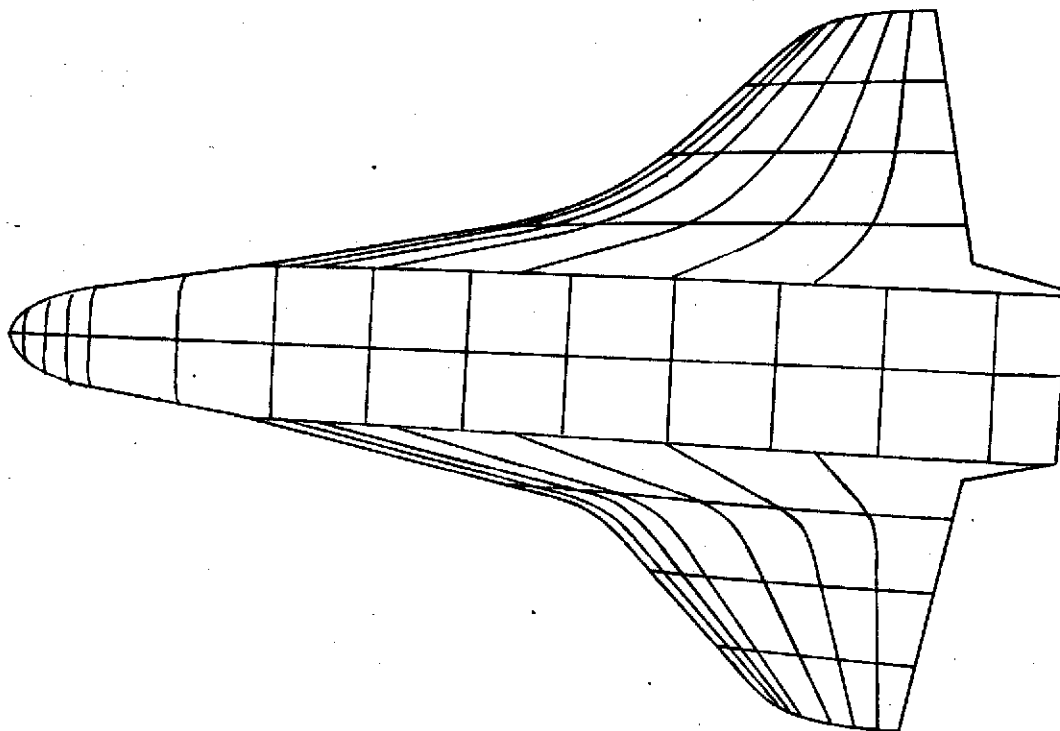
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 38  
FIGURE 12

CONFIG.  
SS-H-00326-4  
LENGTH (#) =  
SCALE .006  
FACILITY LRC-VDT  
TEST  
RUN  
 $M_\infty$  =  
 $P_{total}$  (psia) =  
 $T_{total}$  ( $^{\circ}R$ ) =  
 $T_{aw}/T_{total}$  =  
 $R_N$  per foot =  
 $T_{phase\ change}$  ( $^{\circ}F$ ) =  
 $\alpha$  = 30  
 $\beta$  = 0  
 $\phi$  = 180

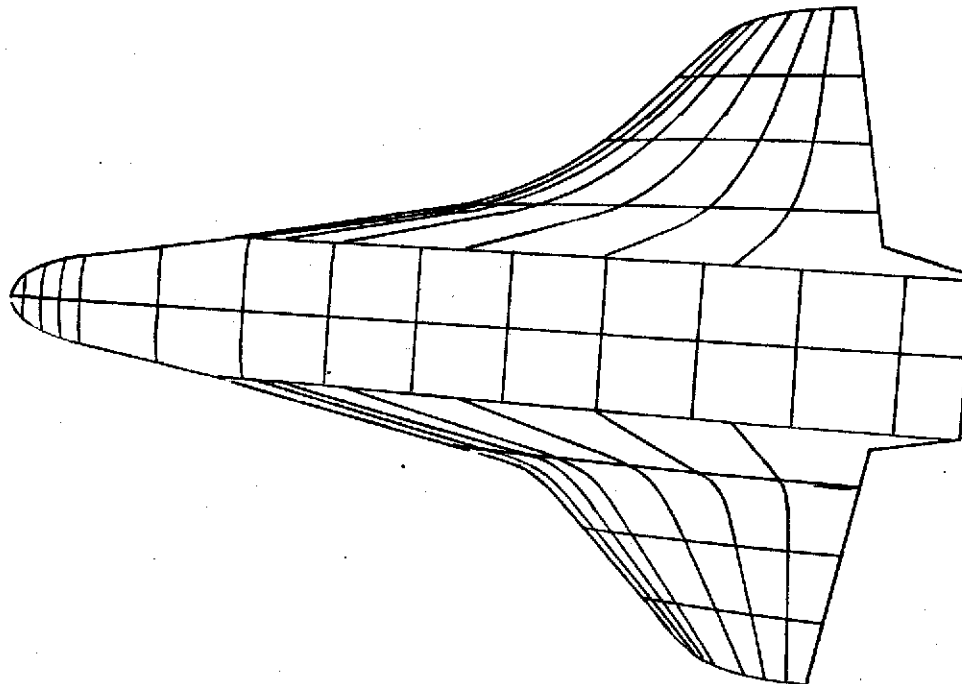
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 39

FIGURE 13

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}$ R) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) =

$\alpha$  = 35

$\beta$  = 0

$\phi$  = 180

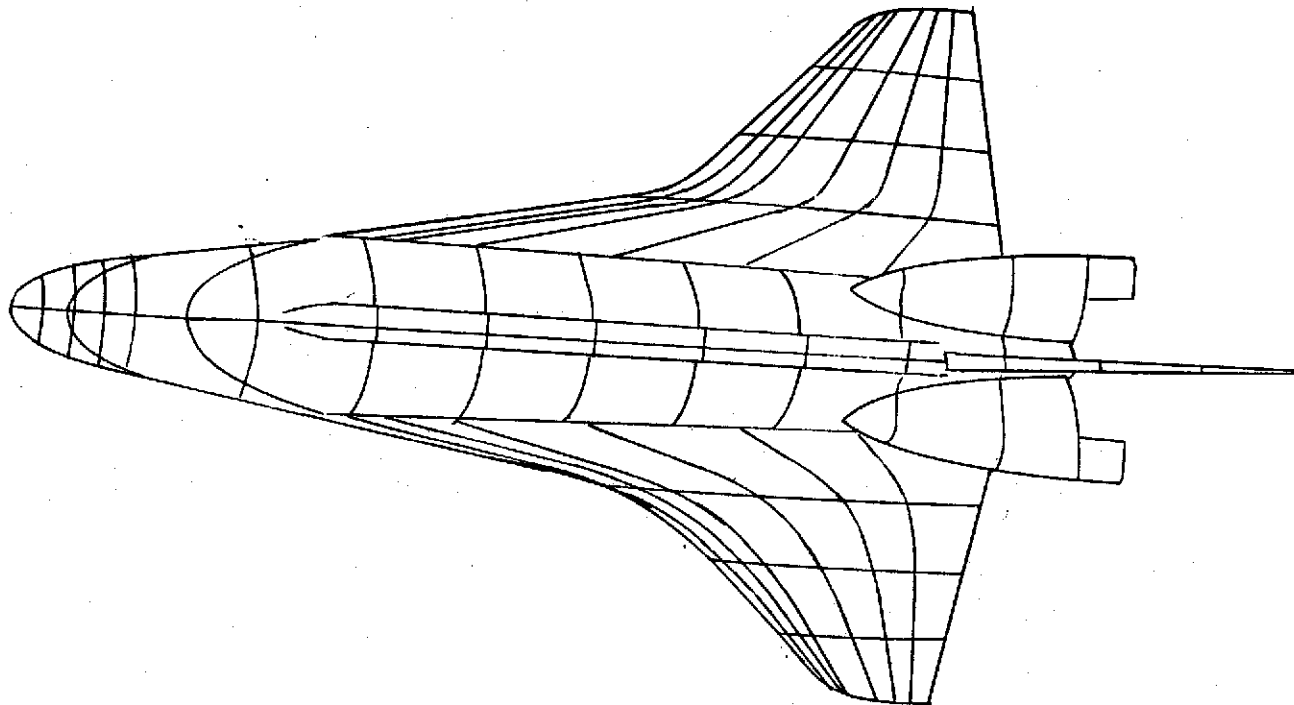
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 40  
FIGURE 14

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}$ R) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) =

$\alpha$  = 0

$\beta$  = 0

$\phi$  = 0

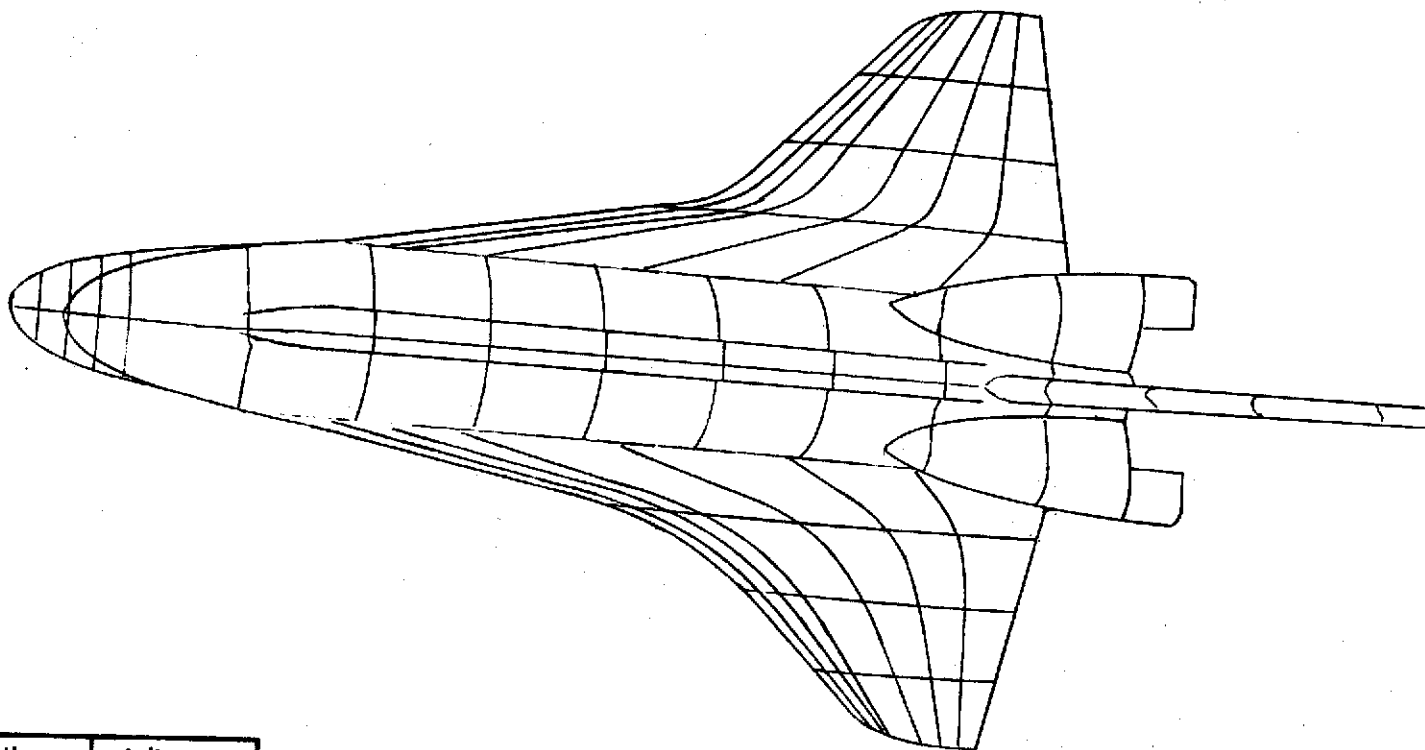
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 15

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha$  = -5

$\beta$  = 0

$\phi$  = 0

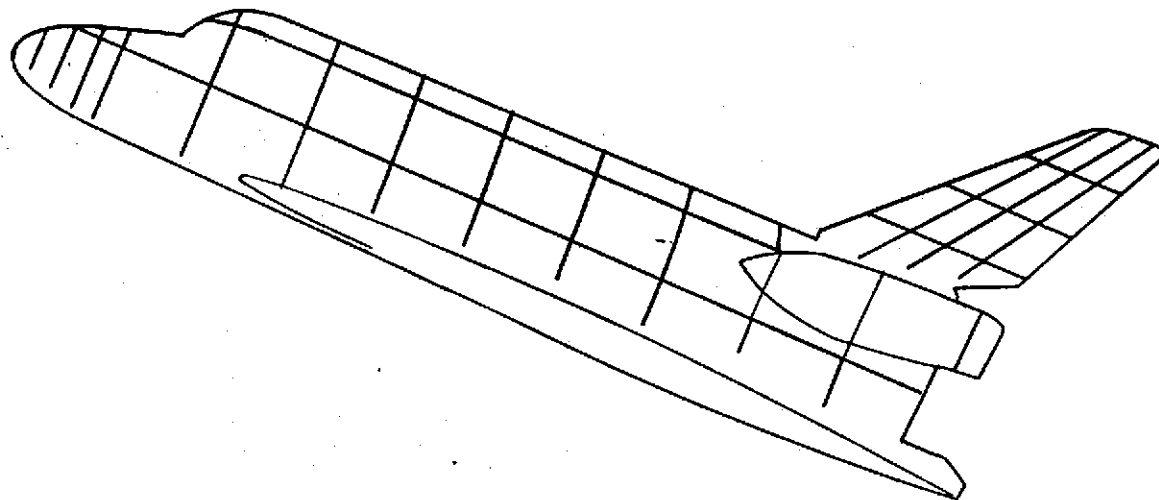
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 16

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty =$

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total} =$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha = 25$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

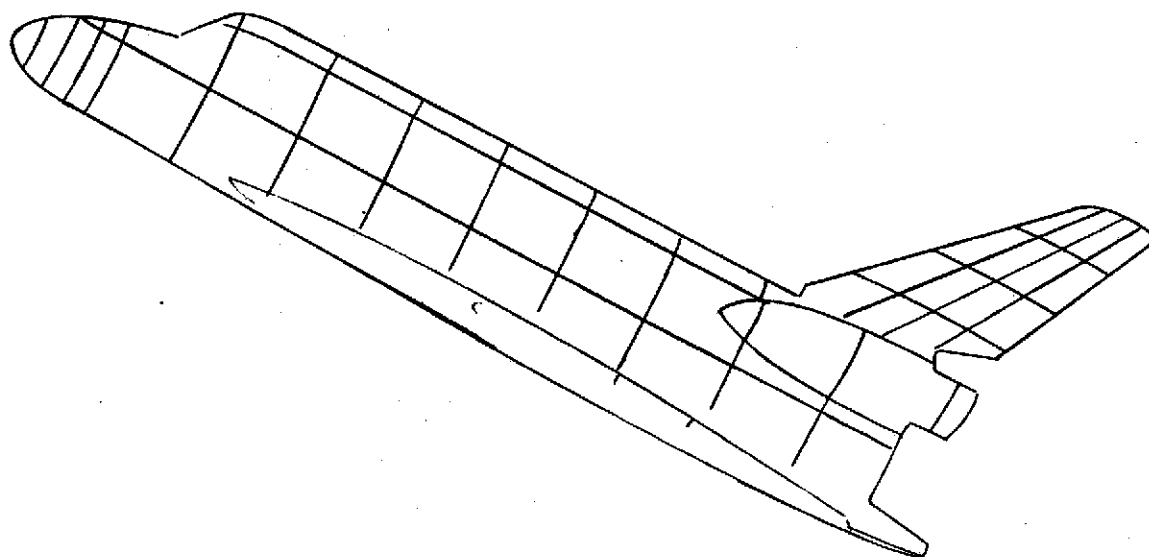
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 17

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}$ R) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) =

$\alpha$  = 30

$\beta$  = 0

$\phi$  = 180

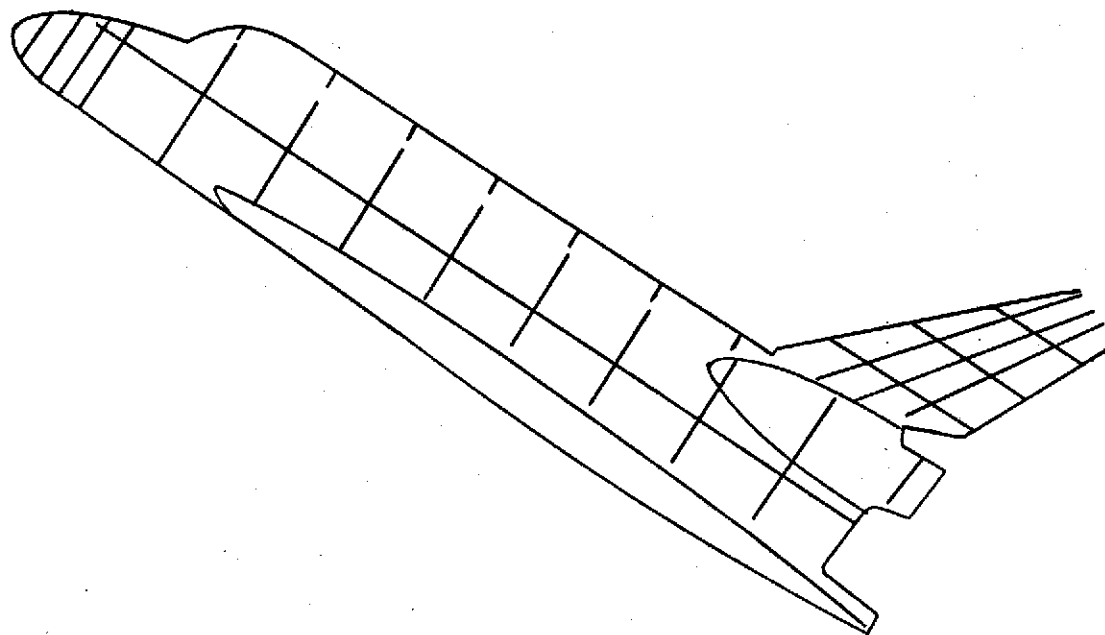
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{y=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 18

CONFIG.

SS-H-00326-4

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN

$M_\infty$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha$  = 35

$\beta$  = 0

$\phi$  = 180

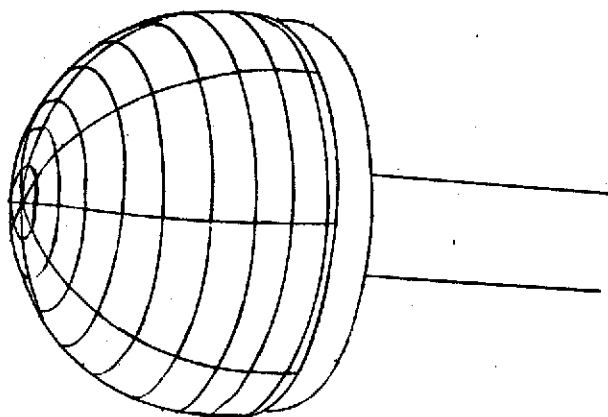
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PAGE 45  
FIGURE 19

CONFIG.

LENGTH (ft) =

SCALE 1.0

FACILITY LRC - VDT

TEST

RUN

$M_{\infty}$  =

$P_{total}$  (psia) =

$T_{total}$  ( $^{\circ}R$ ) =

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) =

$\alpha$  = 0

$\beta$  = 0

$\phi$  = 0

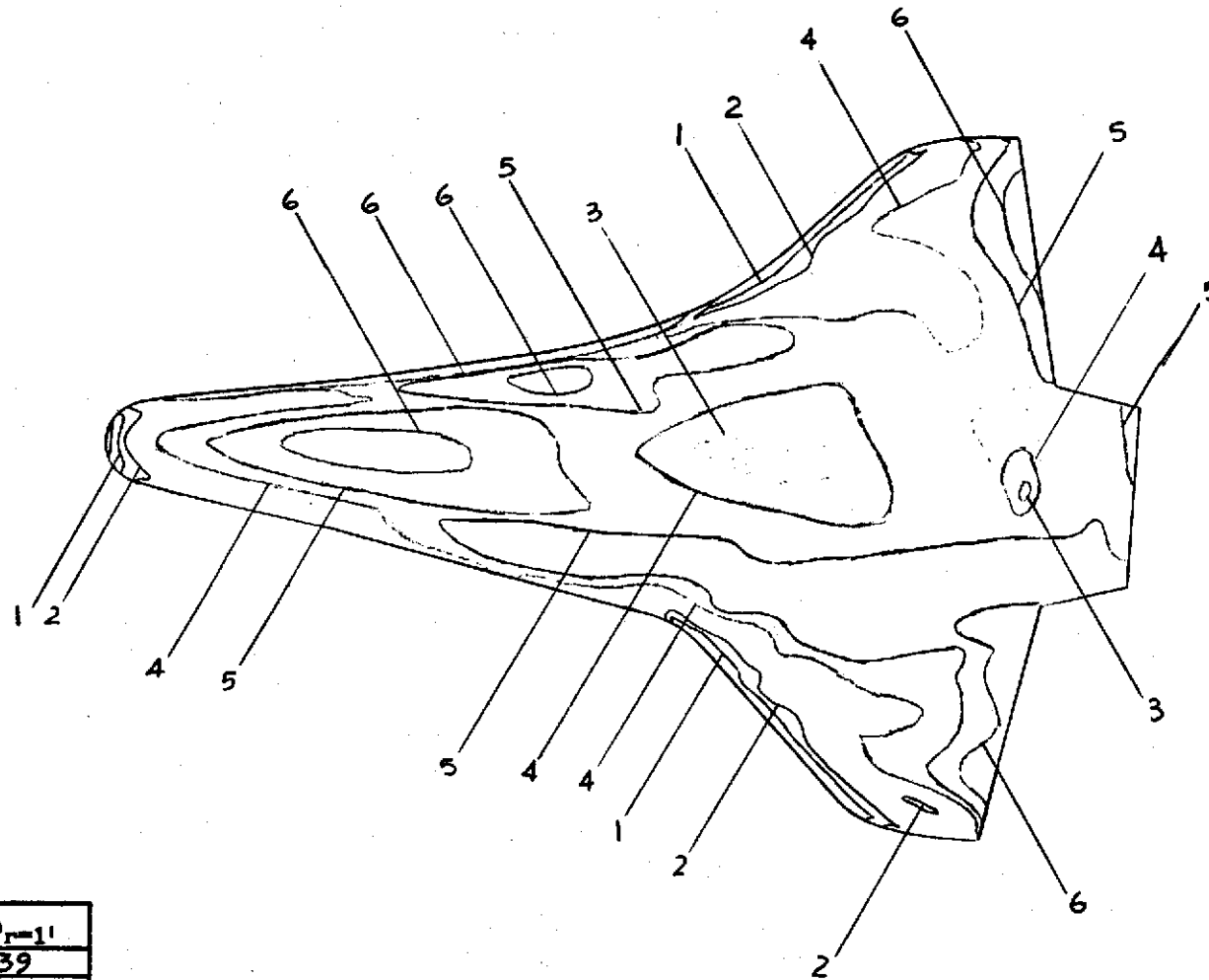
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2839
2	.2177
3	.1518
4	.1310
5	.1073
6	.0848
7	
8	
9	
10	

PAGE 46  
FIGURE 20

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3778

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1375$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

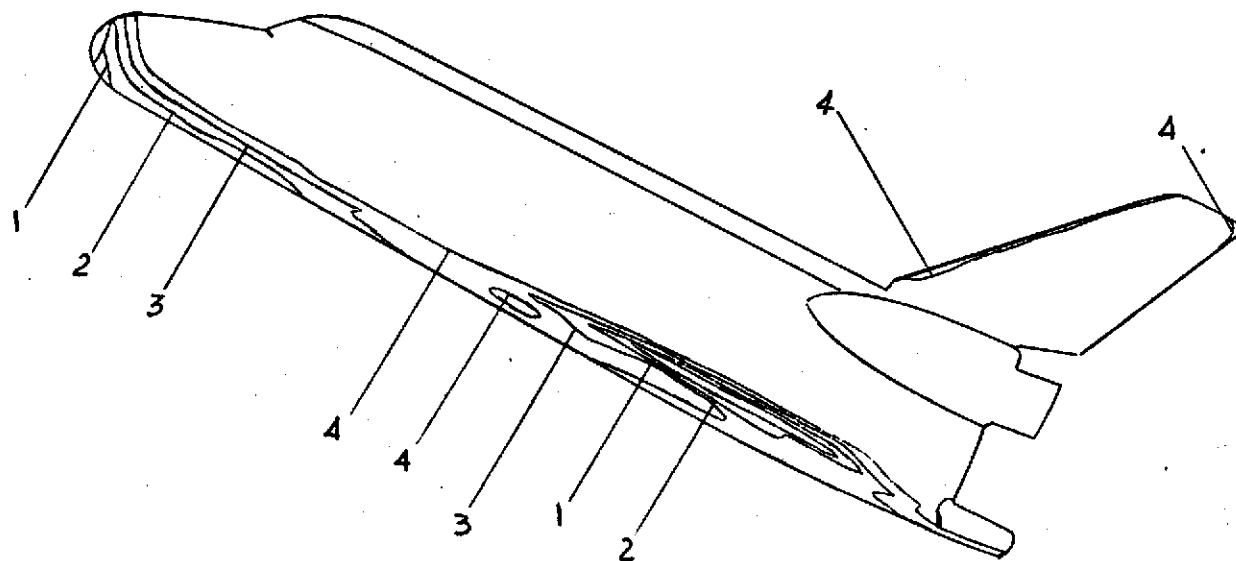
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2915
2	.1742
3	.1211
4	.0900
5	
6	
7	
8	
9	
10	

PAGE 47

FIGURE 21

## CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3778

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}R$ ) = 1375

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 300

$\alpha = 30$

$\beta = 0$

$\phi = 180$

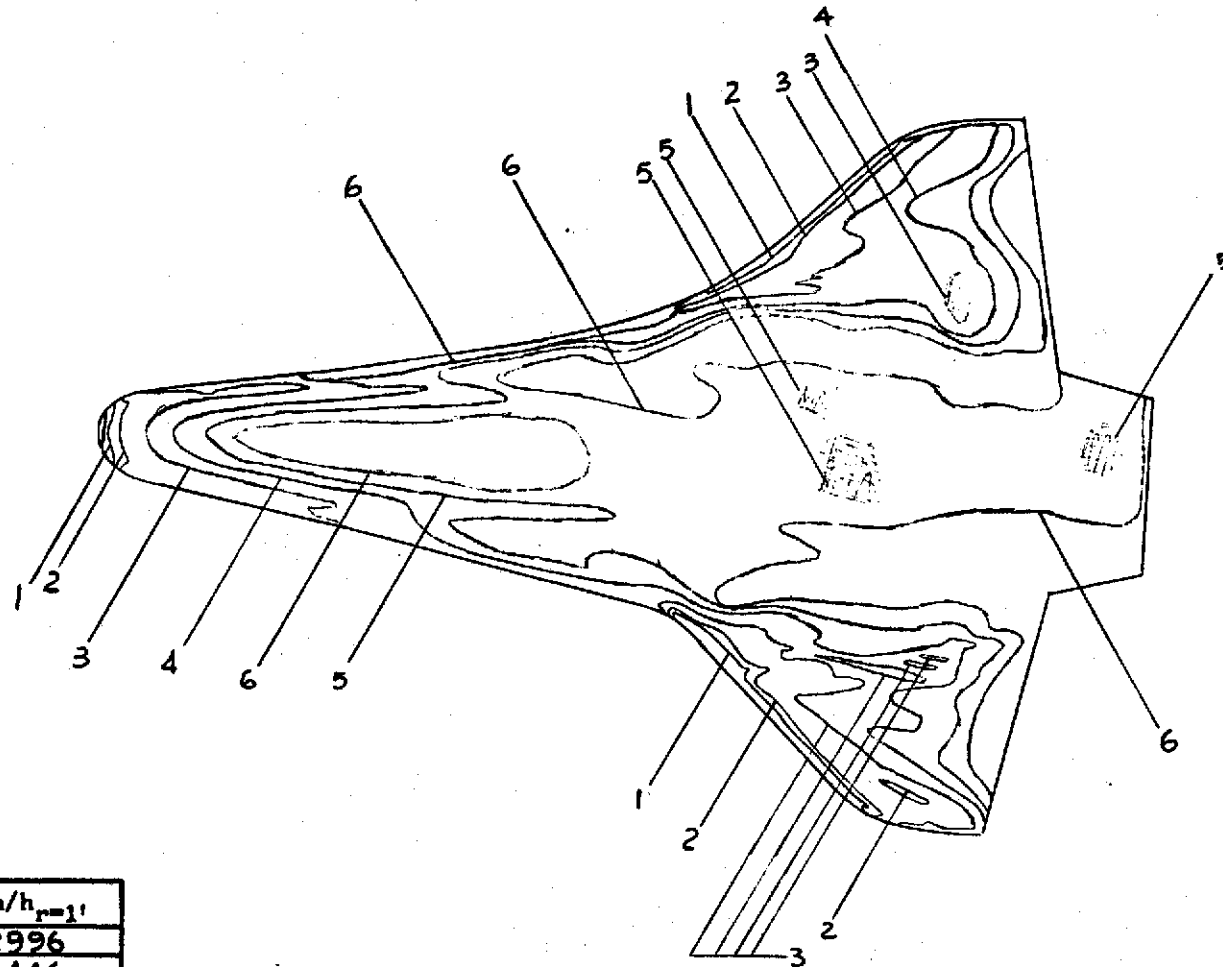
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2996
2	.2446
3	.1579
4	.1203
5	.1022
6	.0893
7	
8	
9	
10	

PAGE 48  
FIGURE 22

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3779

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (}^\circ\text{R)} = 1340$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

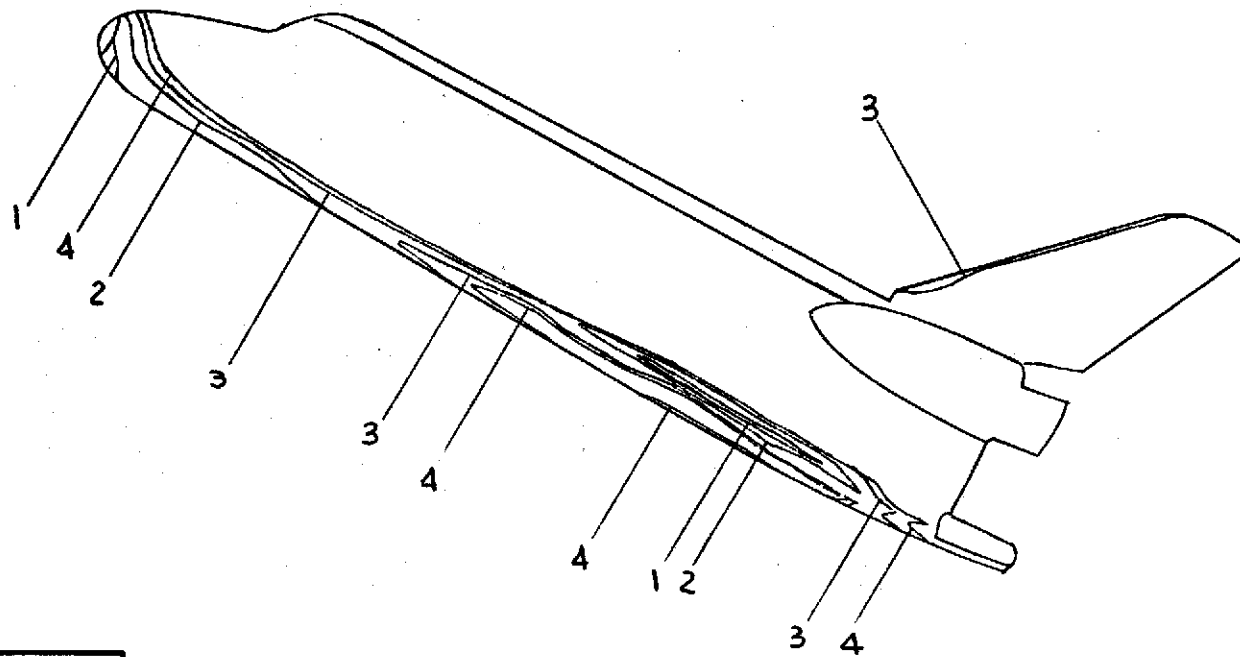
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3080
2	.1580
3	.1103
4	.0233
5	
6	
7	
8	
9	
10	

PAGE 49  
FIGURE 23

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3779

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (°R)} = 1340$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

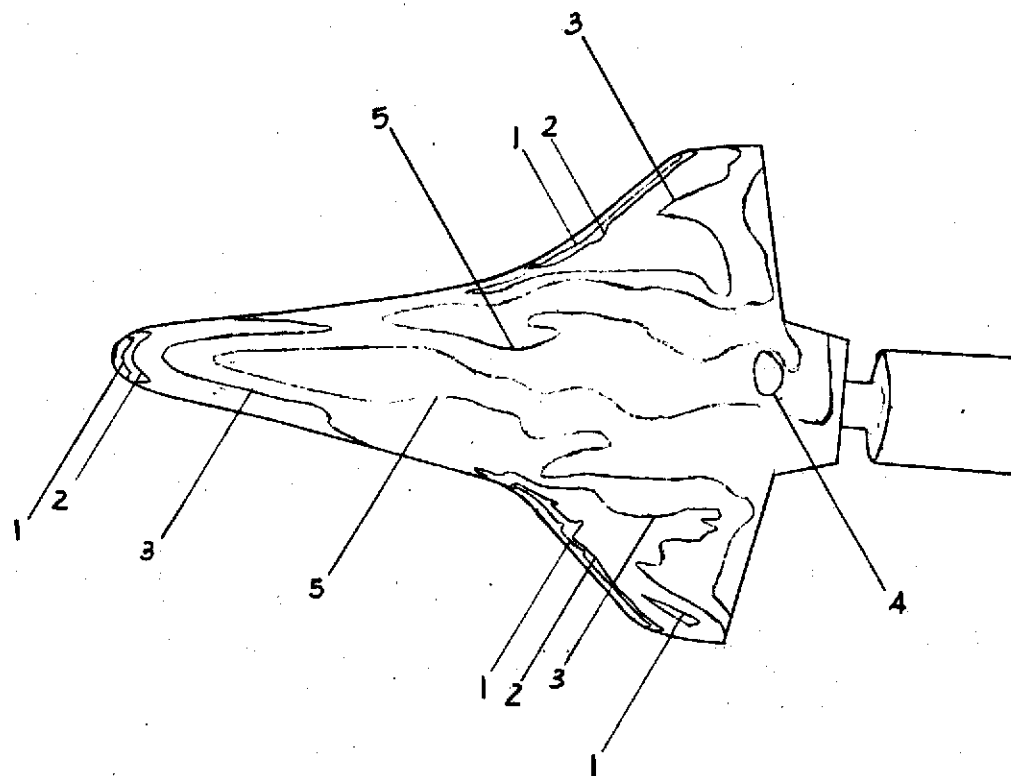
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.3174
2	.2380
3	.1250
4	.0962
5	.0904
6	
7	
8	
9	
10	

PAGE 50  
FIGURE 24

CONFIG.

LENGTH (#) =

SCALE 006

FACILITY LRC-VDT

TEST

RUN 3780

$M_\infty = 7.9$

$P_{total}$  (psia) = 644.7

$T_{total}$  ( $^{\circ}R$ ) = 1335

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 300

$\alpha = 30$

$\beta = 0$

$\phi = 180$

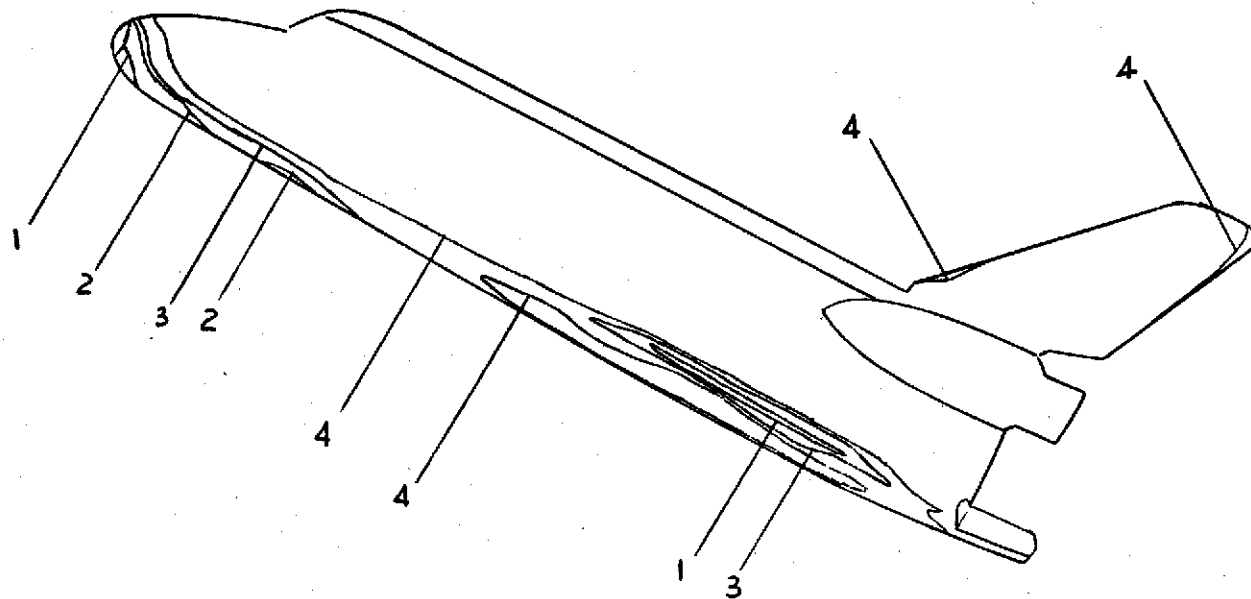
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.3096
2	.1655
3	.1511
4	.0942
5	
6	
7	
8	
9	
10	

PAGE 51  
FIGURE 25

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3780

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1335$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

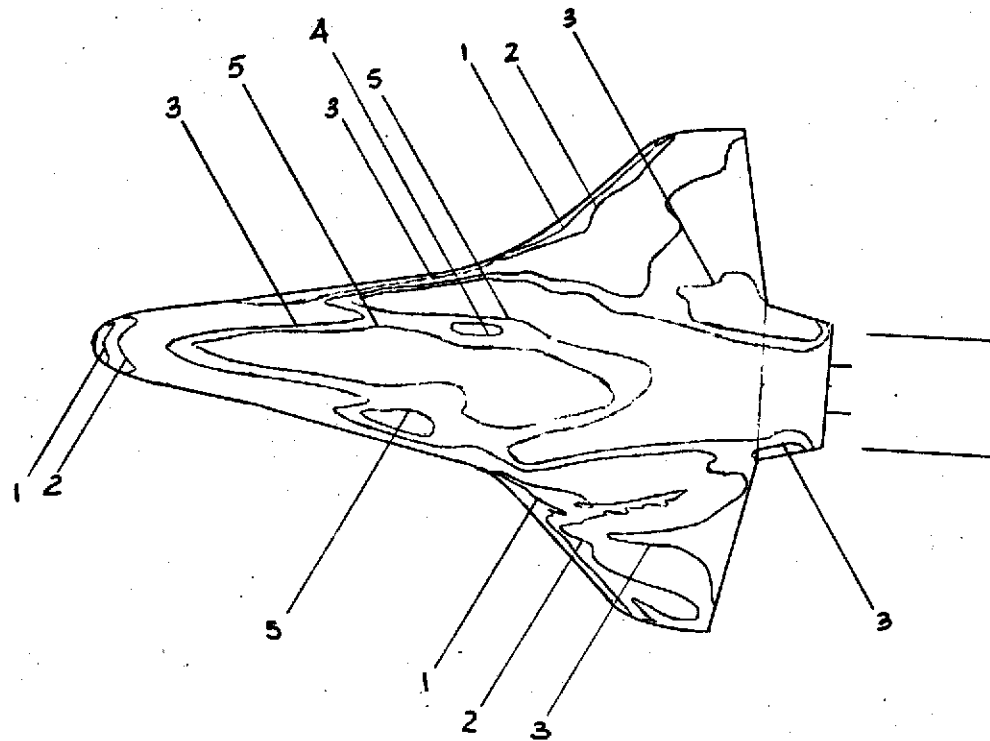
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1'}$
1	.311
2	.205
3	.108
4	.103
5	.095
6	
7	
8	
9	
10	

PAGE 52  
FIGURE 26

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3781

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 634.7$

$T_{total} \text{ (}^\circ\text{R)} = 1325$

$T_{aw}/T_{total} = 91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

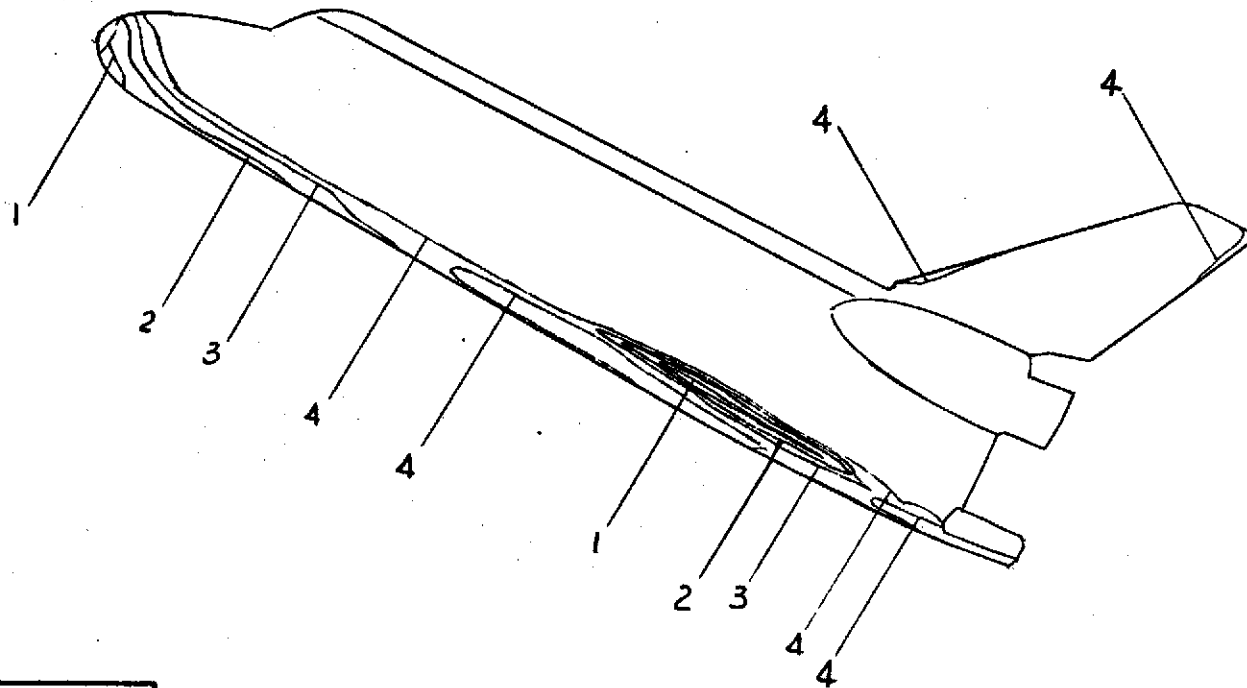
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3181
2	.1751
3	.1332
4	.0973
5	
6	
7	
8	
9	
10	

PAGE 53

FIGURE 27

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3781

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 634.7$

$T_{total} \text{ (}^\circ\text{R)} = 1325$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

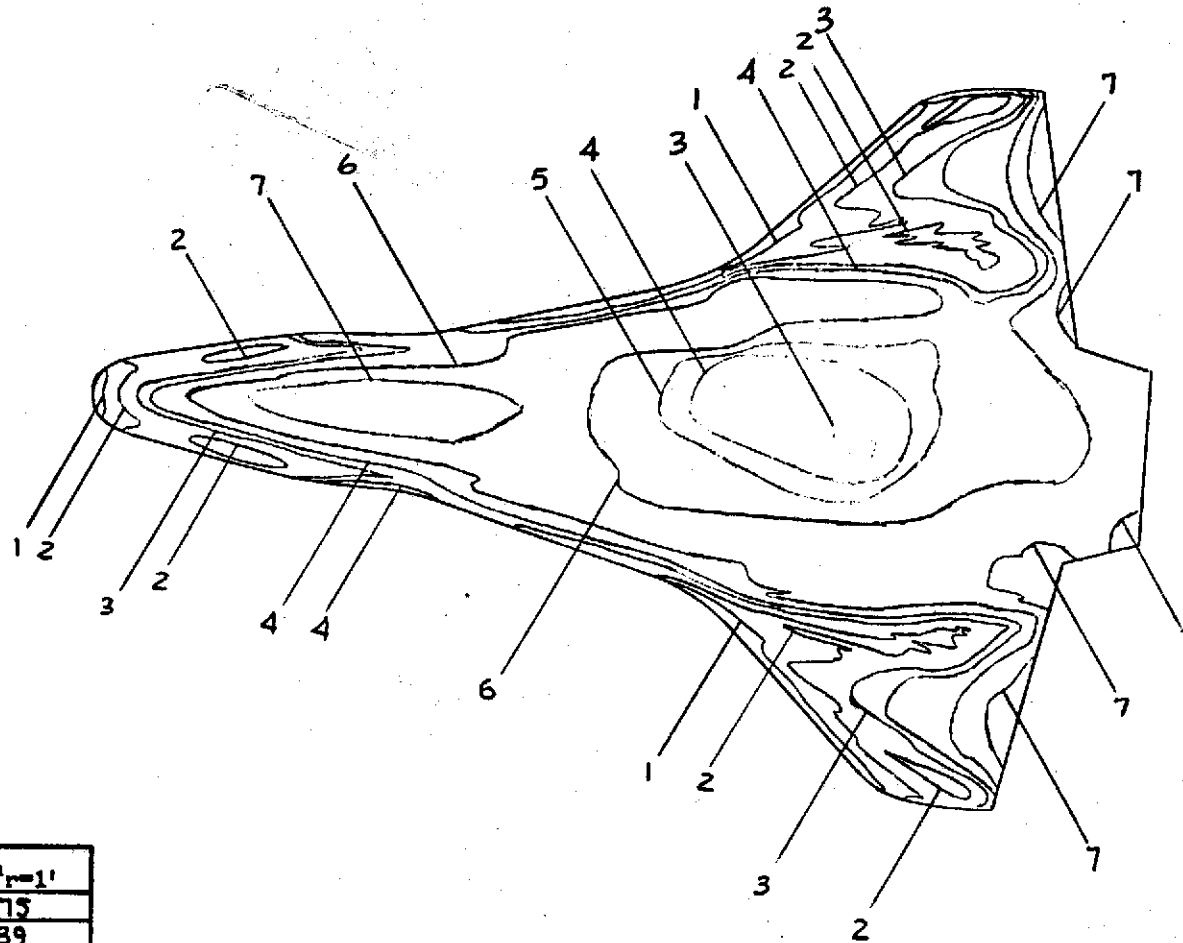
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2775
2	.1689
3	.1280
4	.1162
5	.1133
6	.0994
7	.0811
8	
9	
10	

PAGE 54  
FIGURE 28

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3782

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1375$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

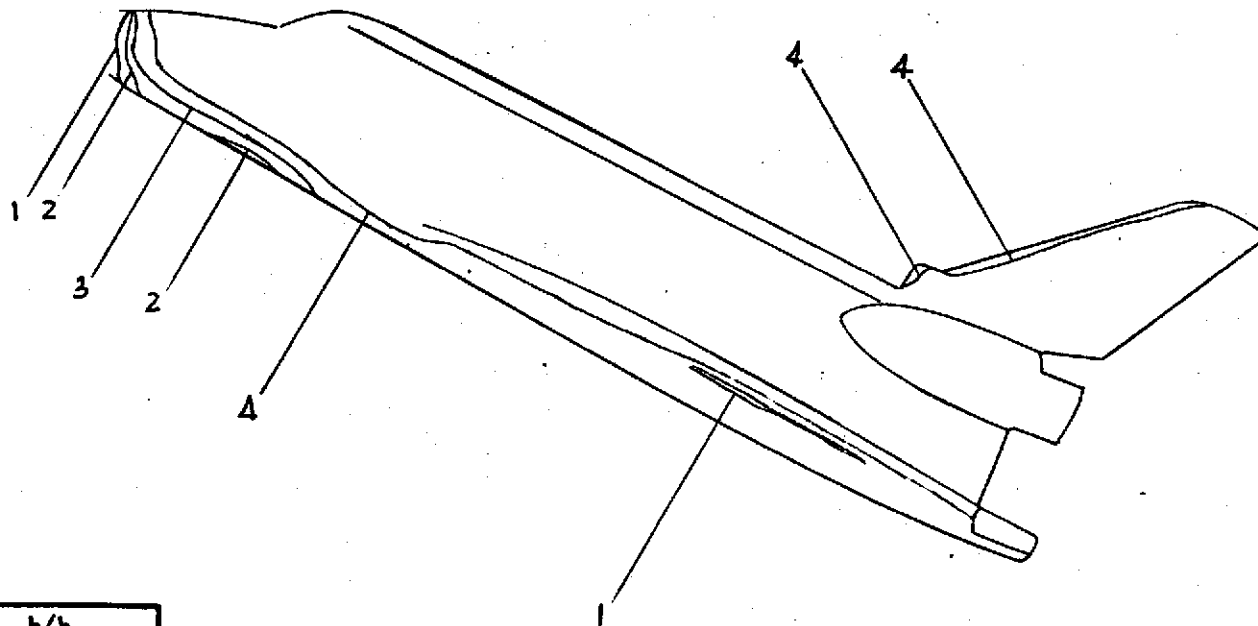
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.3186
2	.2068
3	.1482
4	.0848
5	
6	
7	
8	
9	
10	

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FIGURE 29

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3782

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (}^\circ\text{R)} = 1375$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

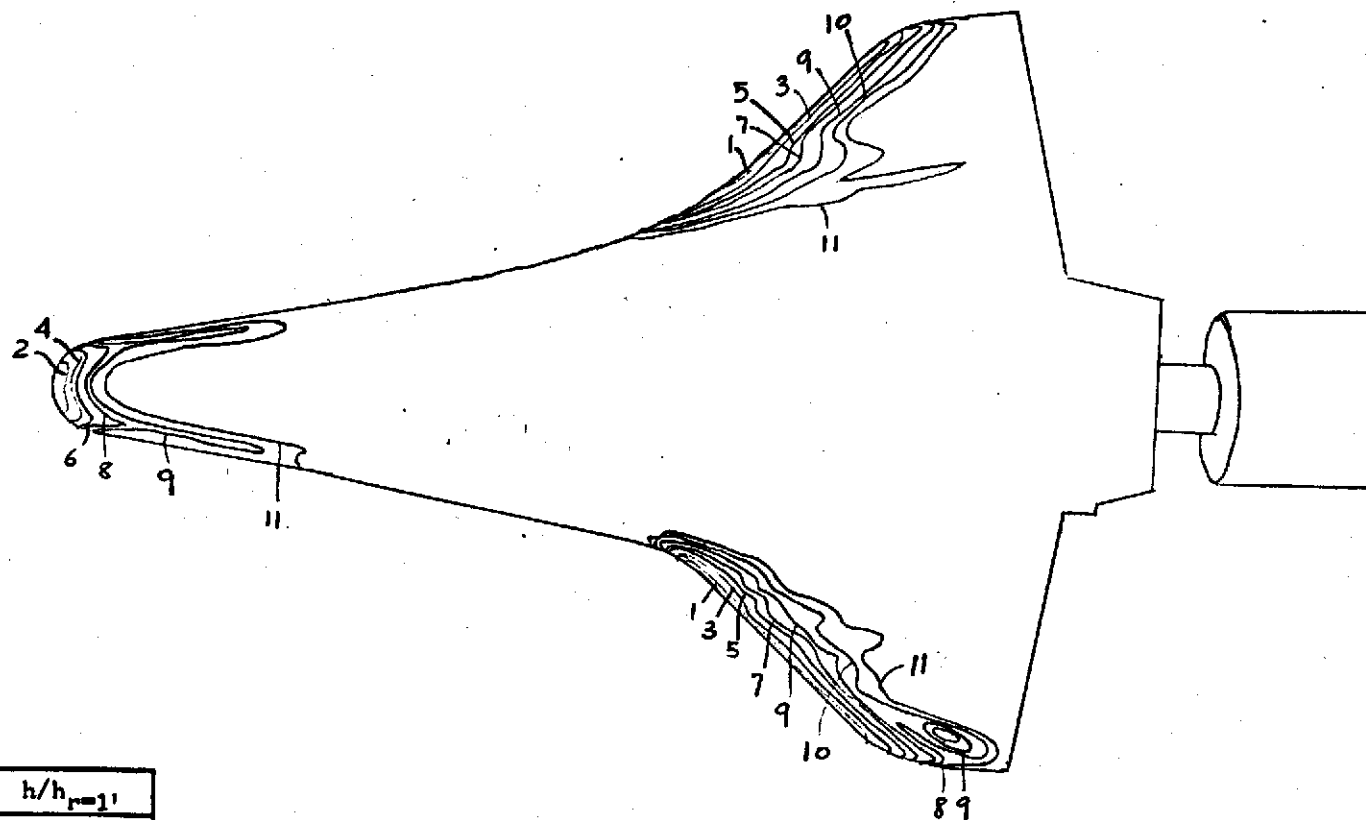
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.4518
2	.3839
3	.3396
4	.2835
5	.2642
6	.2484
7	.2237
8	.2052
9	.1906
10	.1689
11	.1553

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FIGURE 30

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3783

$M_\infty = 7.9$

$P_{total}$  (psia) = 649.7

$T_{total}$  ( $^{\circ}R$ ) = 1365

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

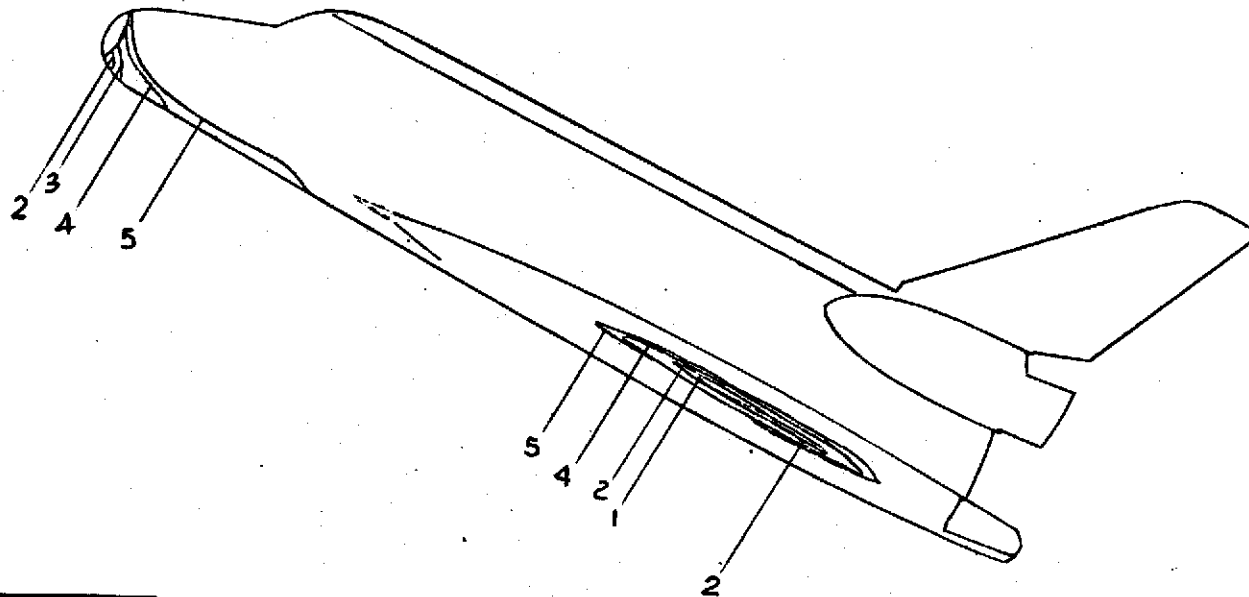
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.5324
2	.4083
3	.3024
4	.1944
5	.1620
6	
7	
8	
9	
10	

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FIGURE 31

CONFIG.

LENGTH (ft) -

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3783

$M_\infty = 7.9$

$P_{total}$  (psia) = 649.7

$T_{total}$  ( $^{\circ}R$ ) = 1365

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

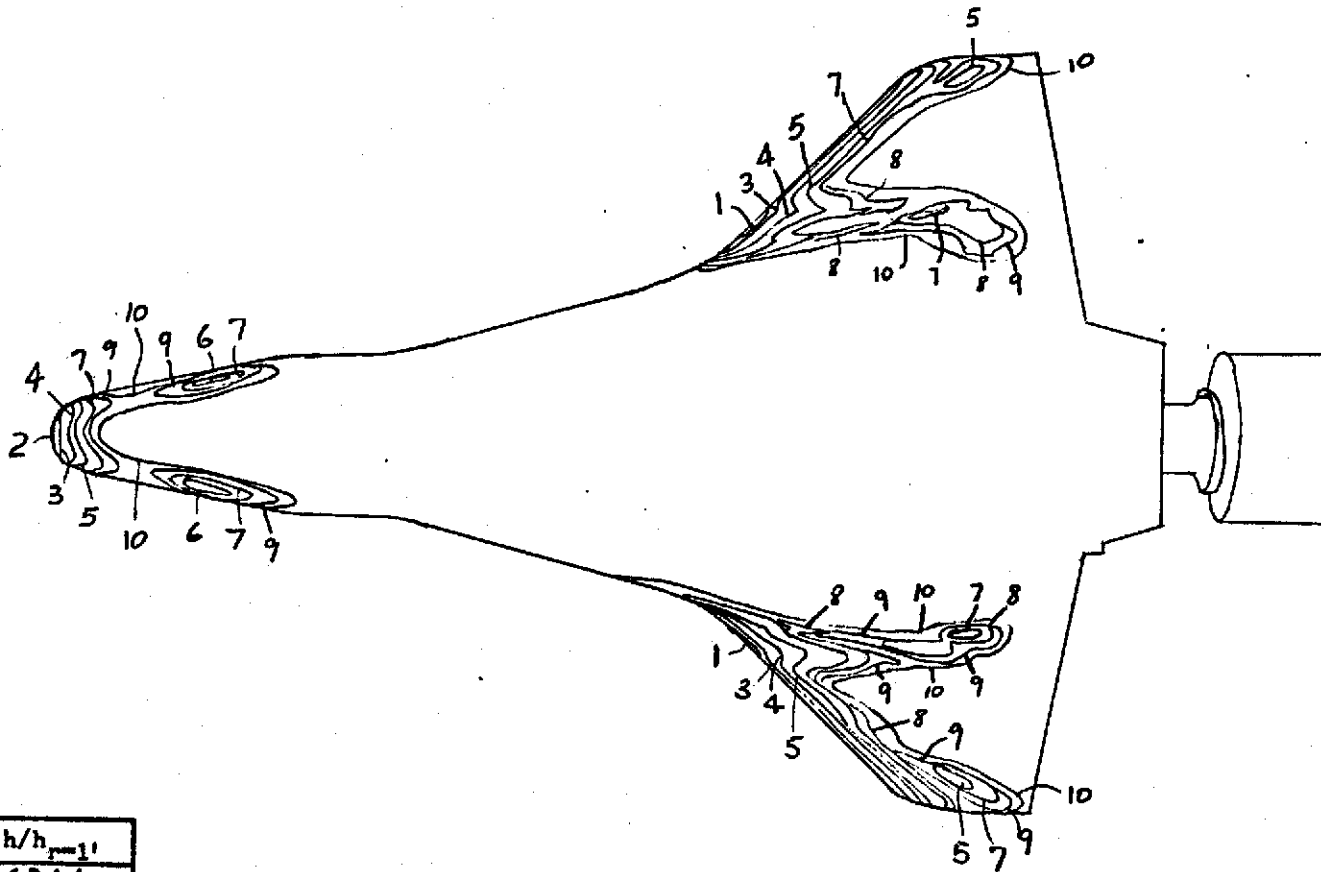
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.6344
2	.4977
3	.4230
4	.3124
5	.2465
6	.2261
7	.2100
8	.1970
9	.1861
10	.1688

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FIGURE 32

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3784

$M_\infty = 7.9$

$P_{total}$  (psia) = 649.7

$T_{total}$  ( $^{\circ}R$ ) = 1325

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

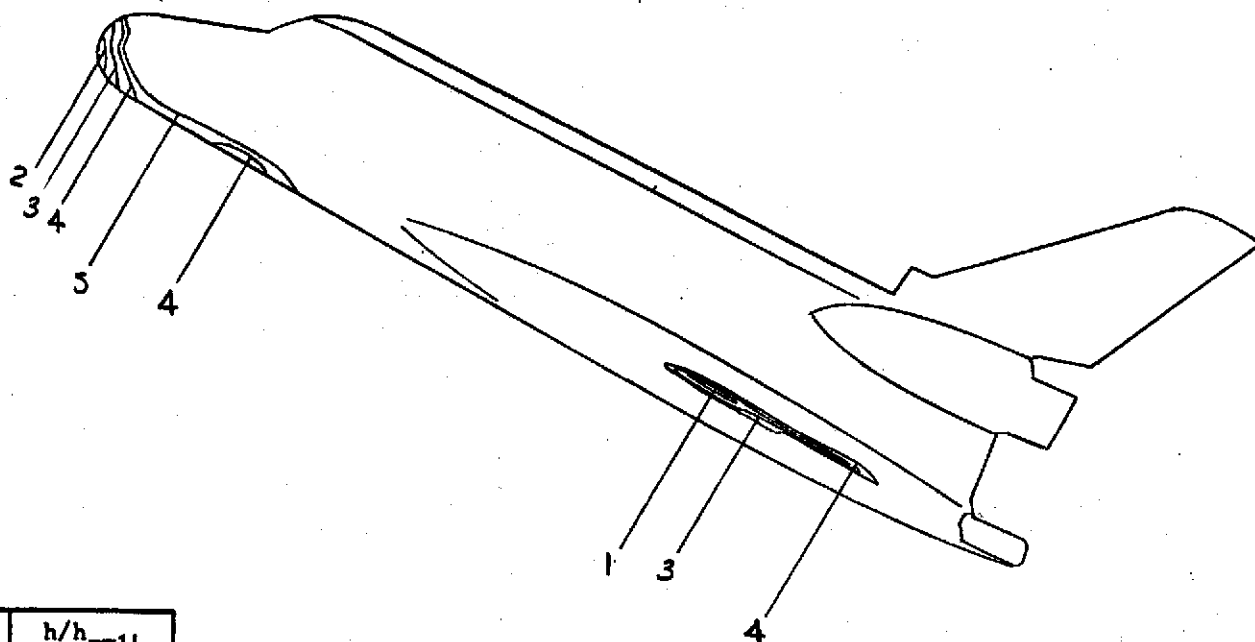
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.5912
2	.4827
3	.3255
4	.2219
5	.1767
6	
7	
8	
9	
10	

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FIGURE 33

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3784

$M_\infty = 7.9$

$P_{total}$  (psia) = 649.7

$T_{total}$  ( $^{\circ}R$ ) = 1325

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

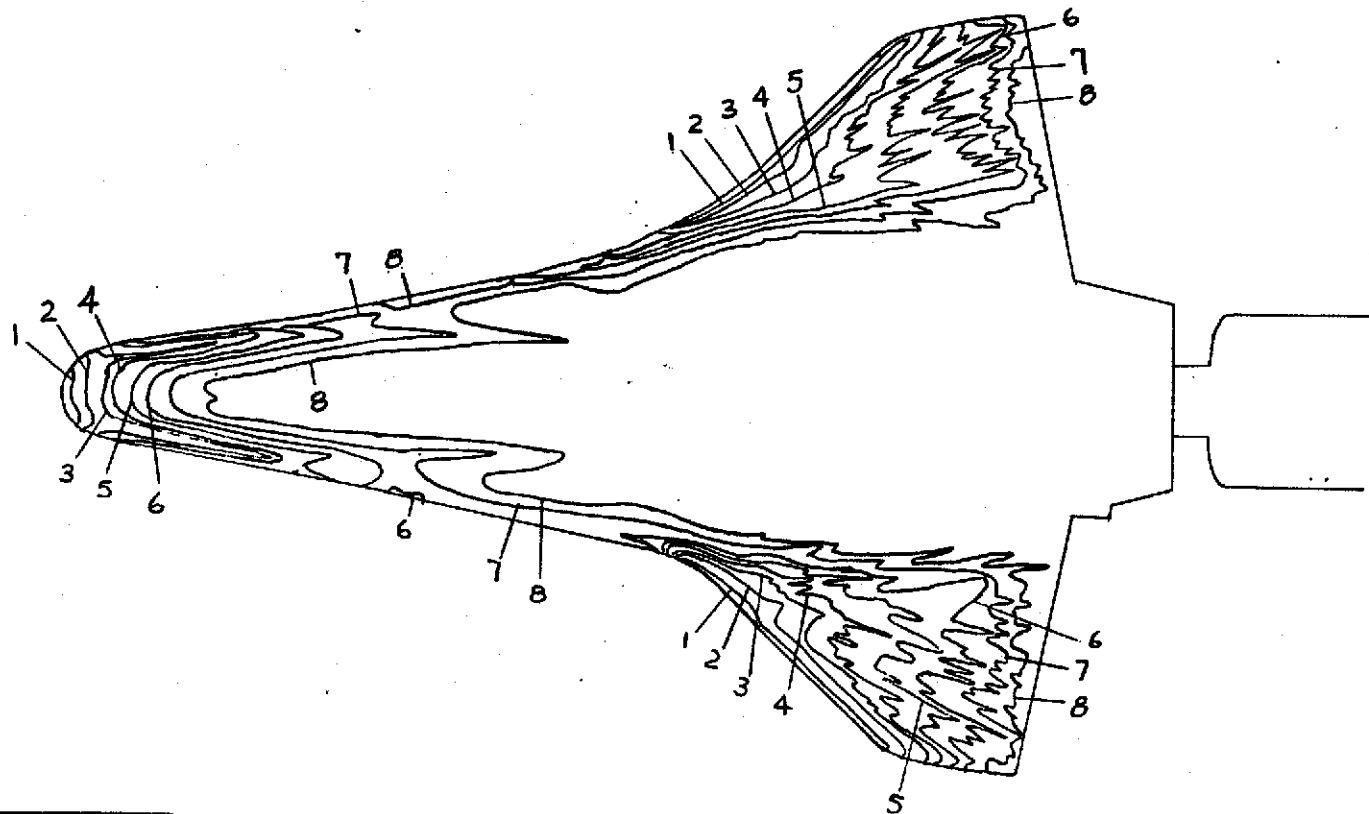
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.3289
2	.2548
3	.1974
4	.1668
5	.1396
6	.1224
7	.1040
8	.0901
9	
10	

PAGE 60  
FIGURE 34

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3785

$M_\infty = 7.9$

$P_{total}$  (psia) = 174.7

$T_{total}$  (°R) = 1295

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

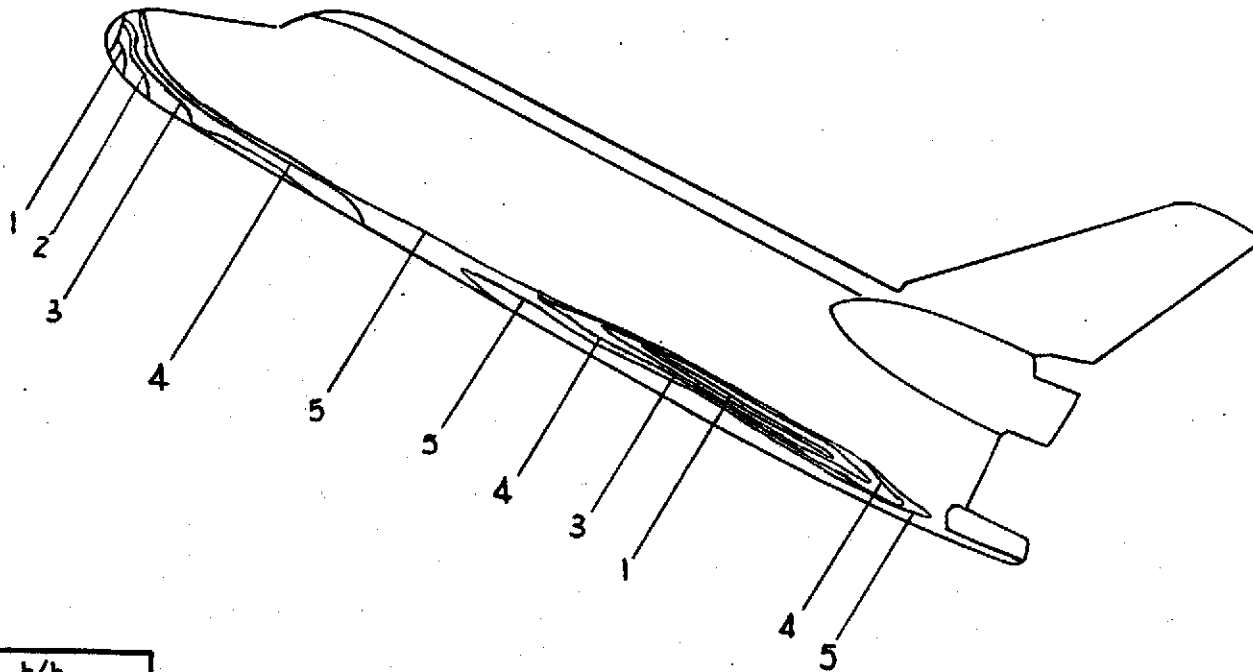
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3199
2	.2065
3	.1641
4	.1153
5	.0894
6	
7	
8	
9	
10	

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FIGURE 35

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3785

$M_\infty = 7.9$

$P_{total}$  (psia) = 174.7

$T_{total}$  ( $^{\circ}R$ ) = 1295

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

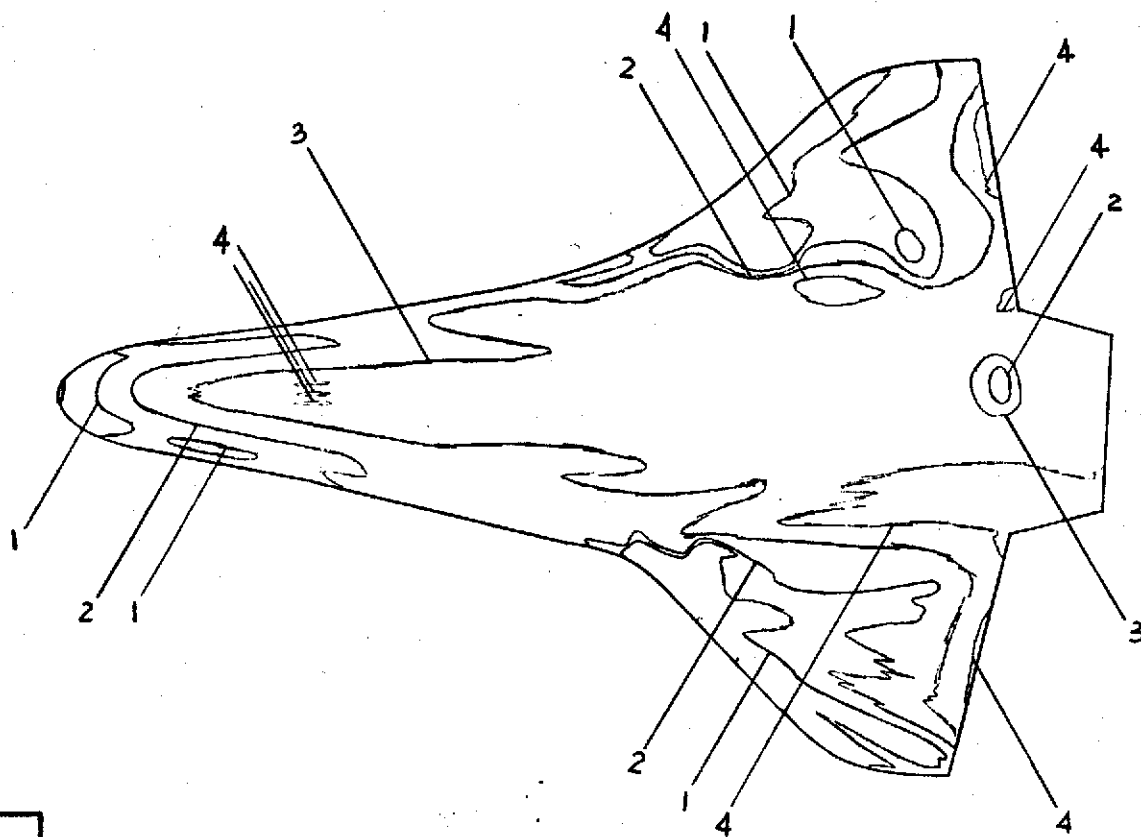
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.1640
2	.1198
3	.0893
4	.0743
5	
6	
7	
8	
9	
10	

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FIGURE 36

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3786

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1380$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

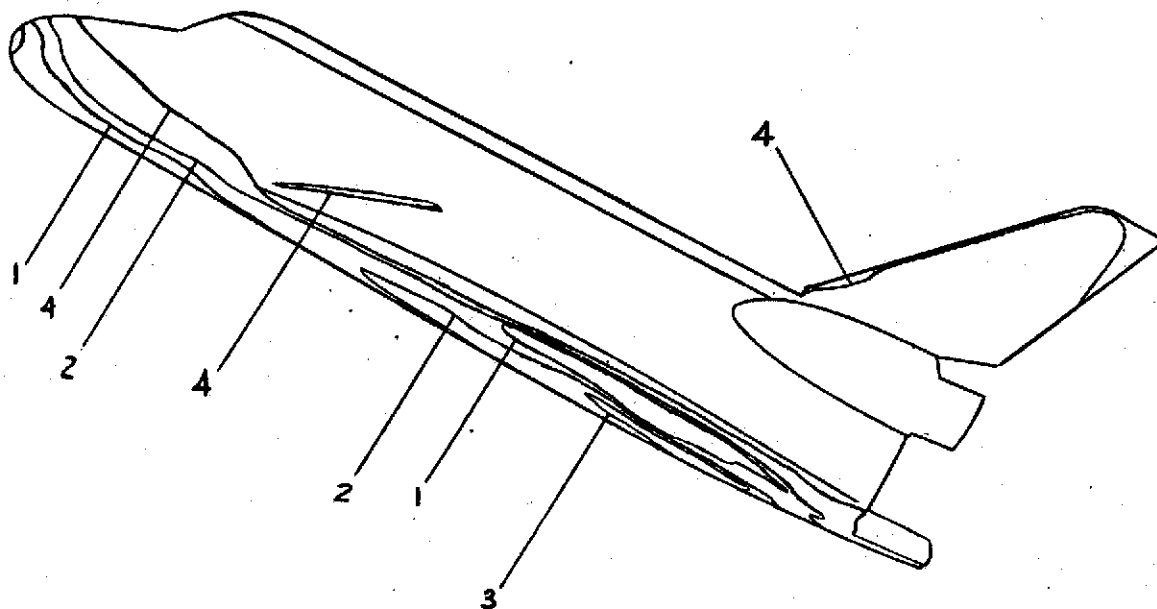
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1501
2	.0969
3	.0791
4	.0459
5	
6	
7	
8	
9	
10	

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FIGURE 37

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3786

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1380$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

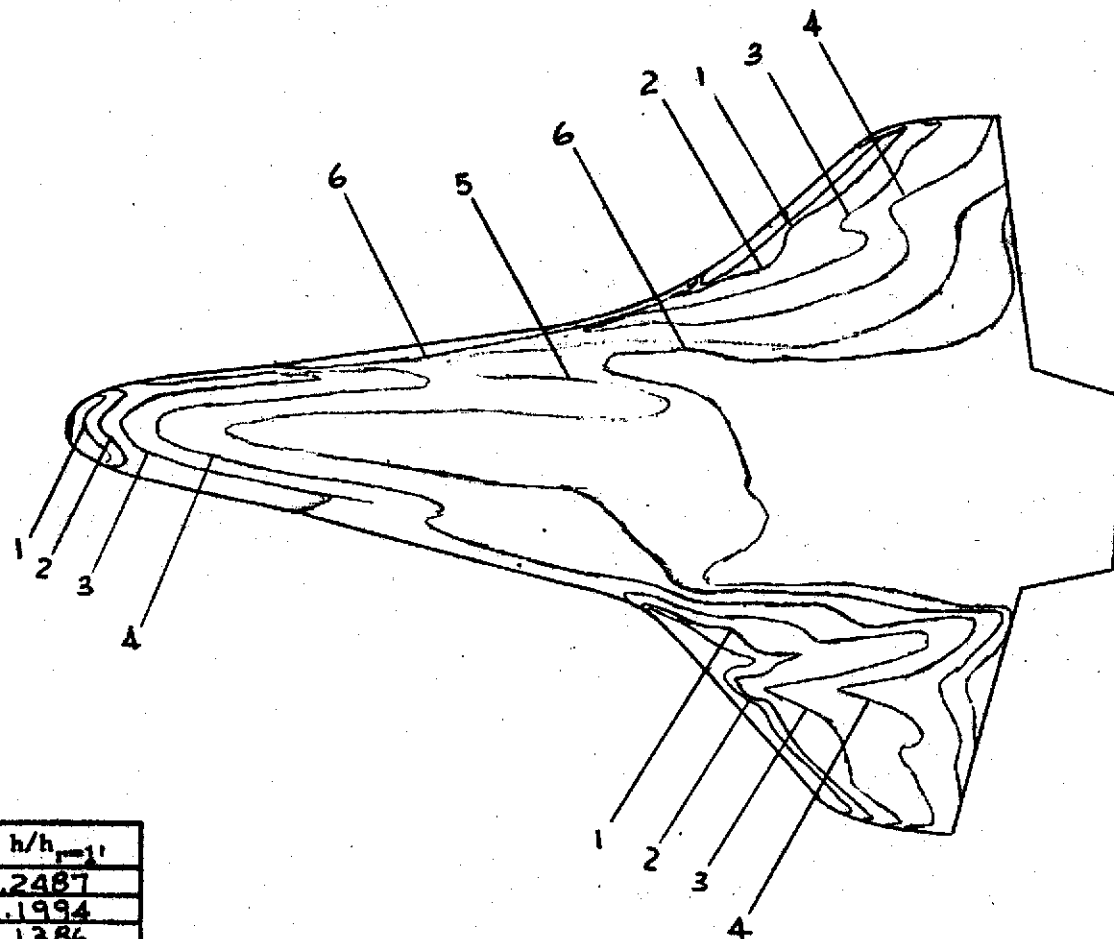
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{max}}$
1	.2487
2	.1994
3	.1386
4	.0980
5	.0739
6	.0642
7	
8	
9	
10	

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FIGURE 38

## CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3787

$M_\infty = 7.9$

$P_{\text{total}}$  (psia) = 174.7

$T_{\text{total}}$  ( $^{\circ}\text{R}$ ) = 1260

$T_{\text{aw}}/T_{\text{total}} = .91$

$R_N$  per foot =

$T_{\text{phase change}}$  ( $^{\circ}\text{F}$ ) = 182

$\alpha = 30$

$\beta = 0$

$\phi = 180$

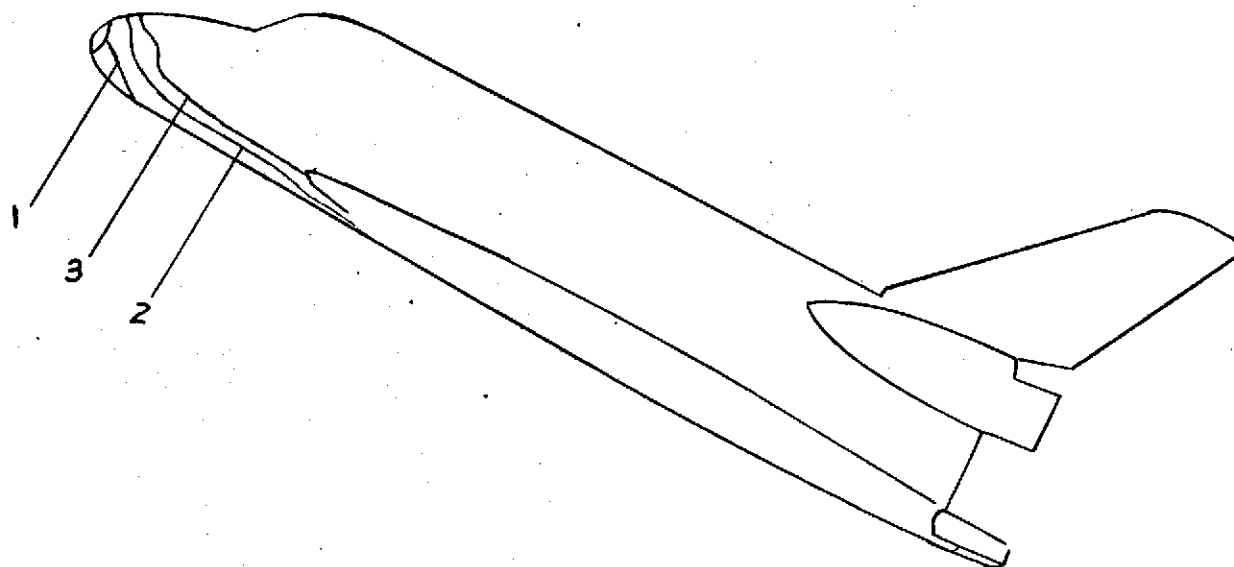
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1'}$
1	.2418
2	.1209
3	.0663
4	
5	
6	
7	
8	
9	
10	

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FIGURE 39

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3787

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^\circ\text{R)} = 1260$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 182$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

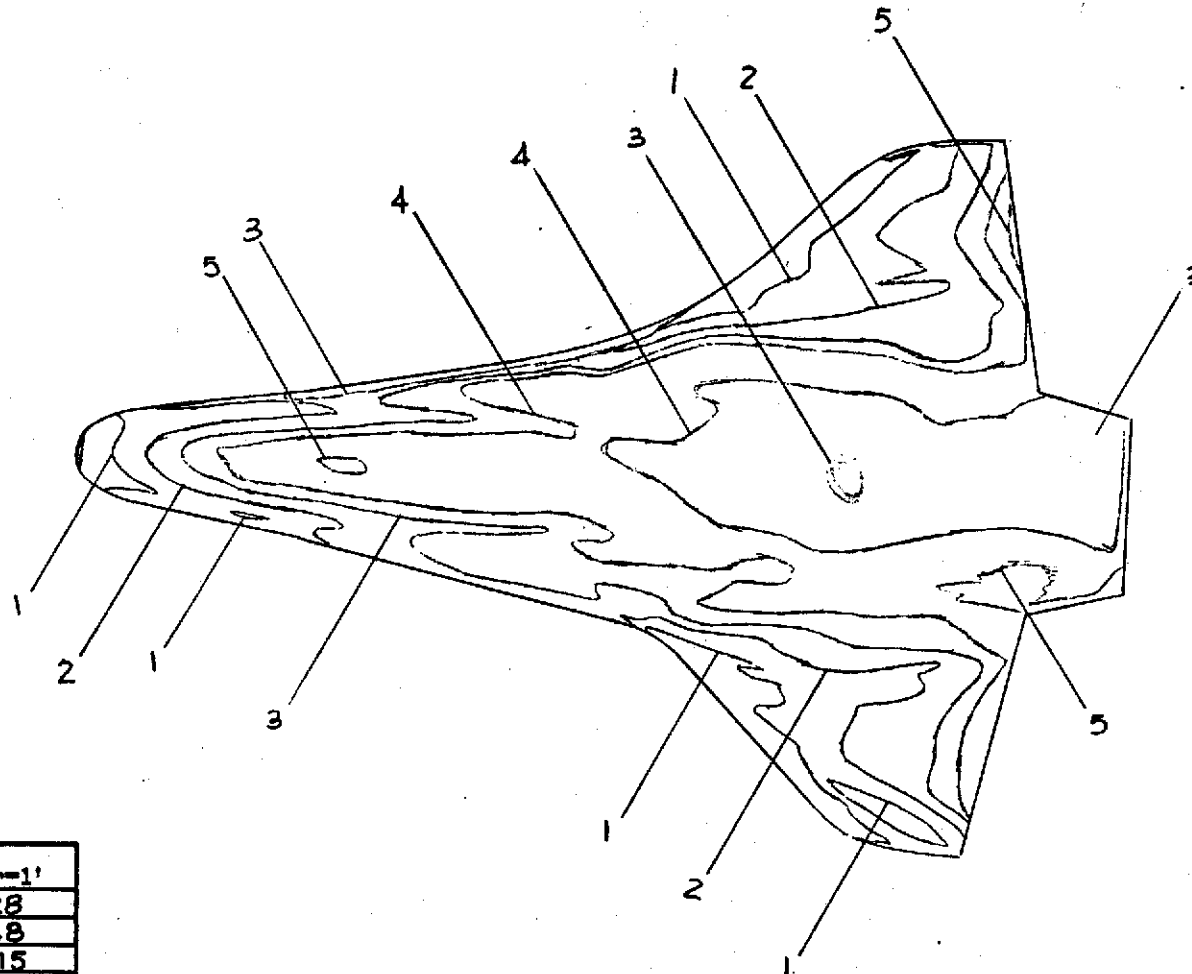
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

$x \text{ (in)} =$

$y \text{ (in)} =$

$z \text{ (in)} =$

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.1728
2	.1268
3	.0975
4	.0821
5	.0674
6	
7	
8	
9	
10	

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FIGURE 40

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3788

$M_\infty = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}R$ ) = 1385

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

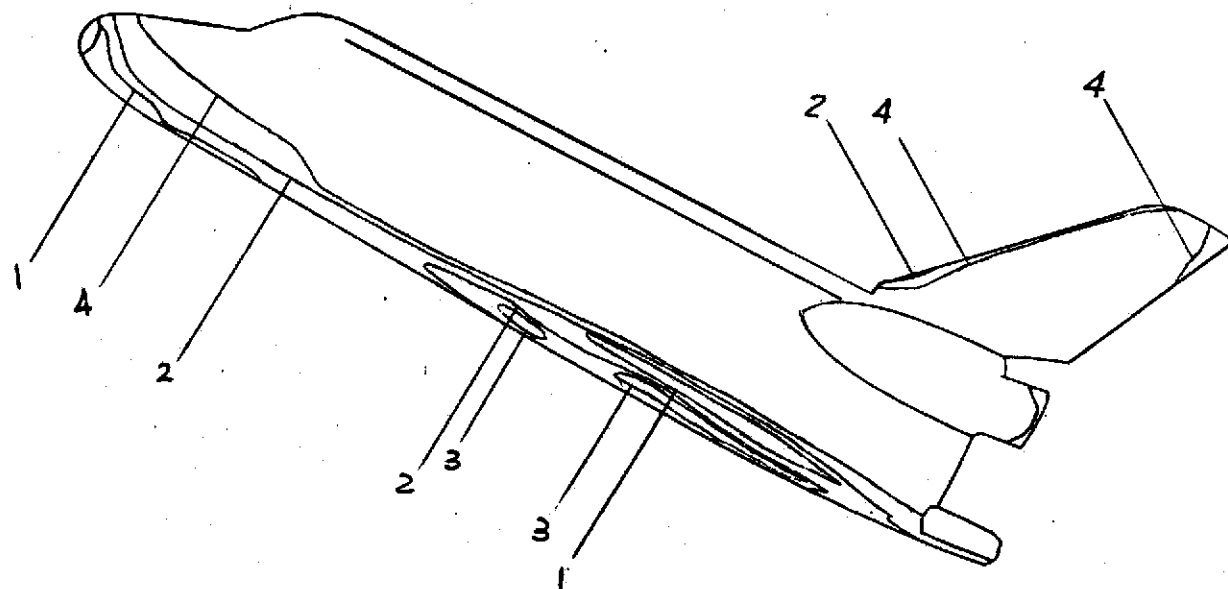
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.1479
2	.0864
3	.0759
4	.0450
5	
6	
7	
8	
9	
10	

PAGE 67  
FIGURE 41

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3788

$M_\infty = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}R$ ) = 1385

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

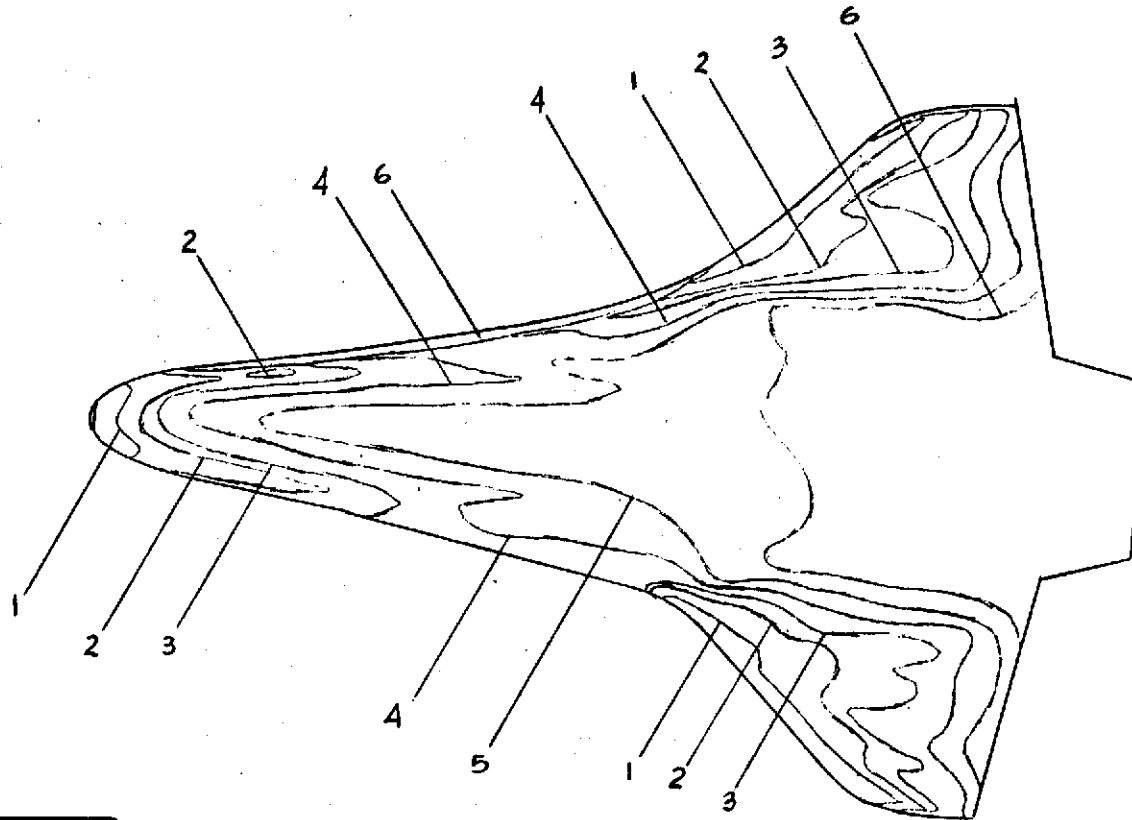
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2199
2	.1482
3	.1210
4	.0929
5	.0772
6	.0617
7	
8	
9	
10	

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FIGURE 42

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3789

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 177.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1285$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 182$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

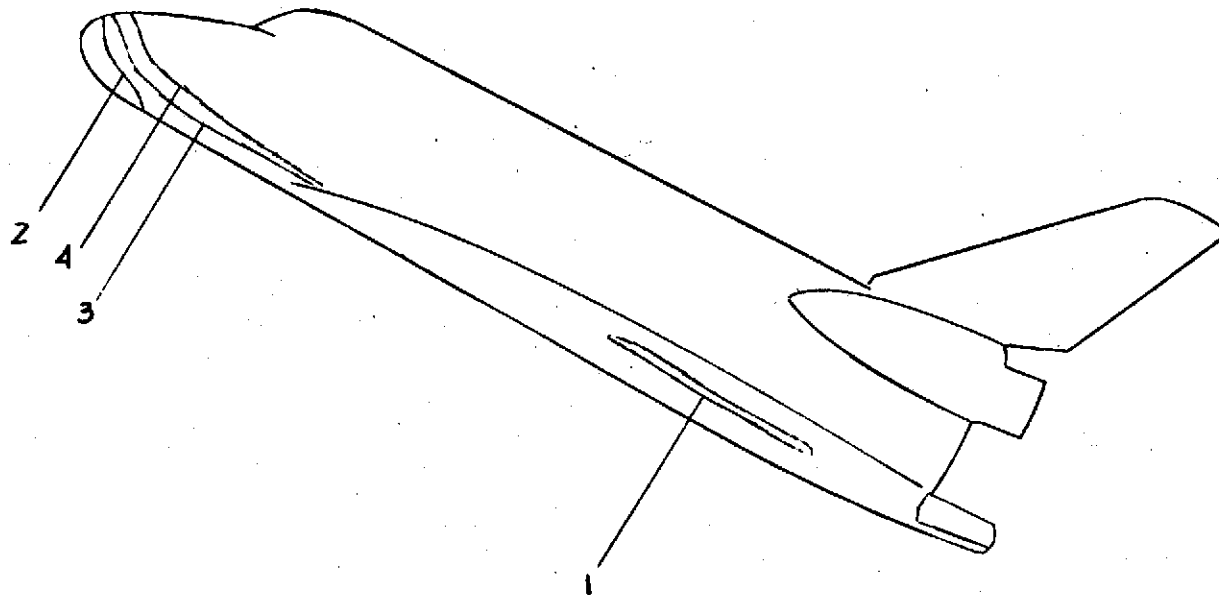
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2251
2	.1633
3	.0919
4	.0624
5	
6	
7	
8	
9	
10	

PAGE 69  
FIGURE 43

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3789

$M_\infty = 7.9$

$P_{total}$  (psia) = 177.7

$T_{total}$  ( $^{\circ}R$ ) = 1285

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 182

$\alpha = 30$

$\beta = 0$

$\phi = 180$

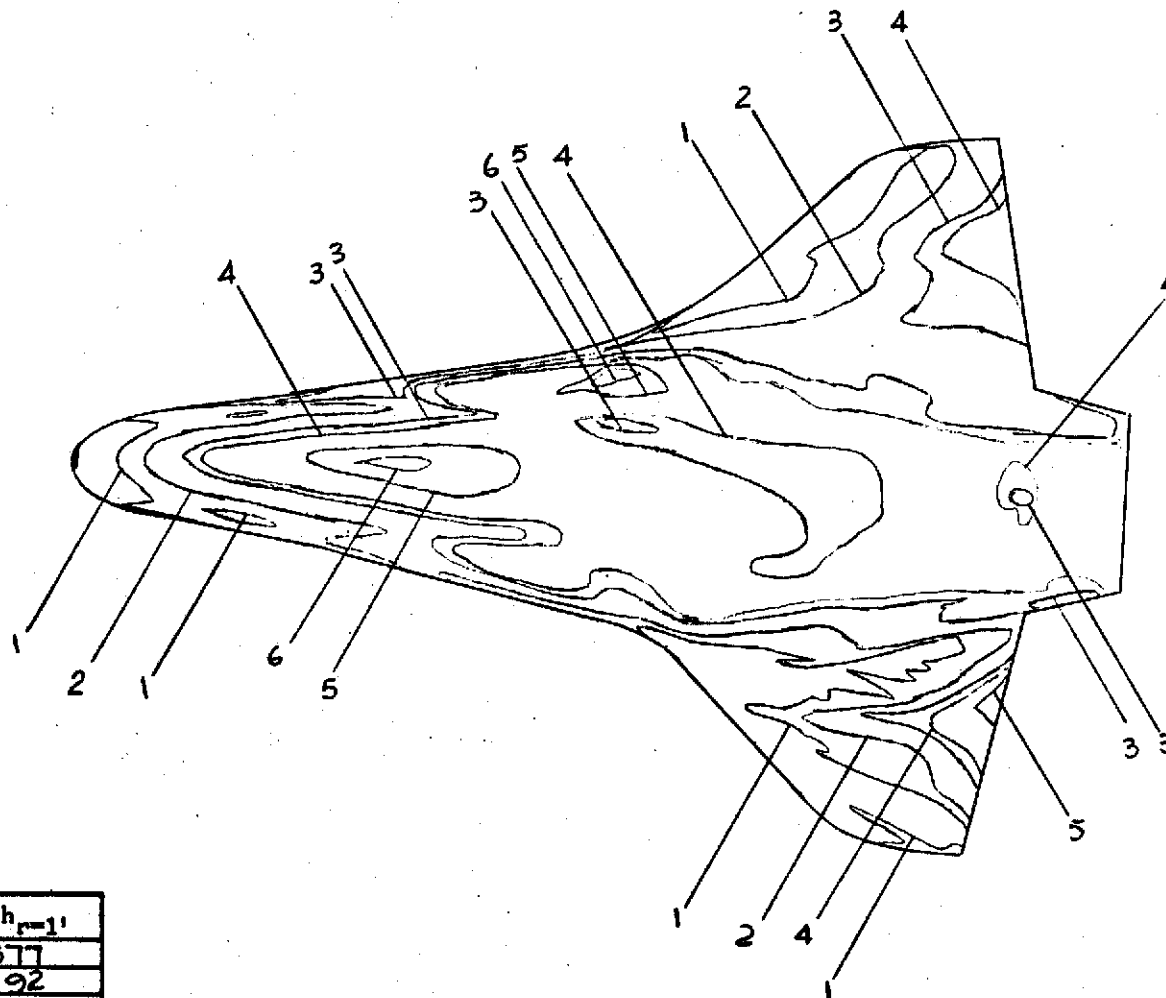
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1577
2	.1192
3	.0951
4	.0875
5	.0703
6	.0638
7	
8	
9	
10	

PAGE 70

FIGURE 44

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3790

$M_\infty = 7.9$

$P_{total}$  (psia) = 649.7

$T_{total}$  ( $^{\circ}R$ ) = 1385

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

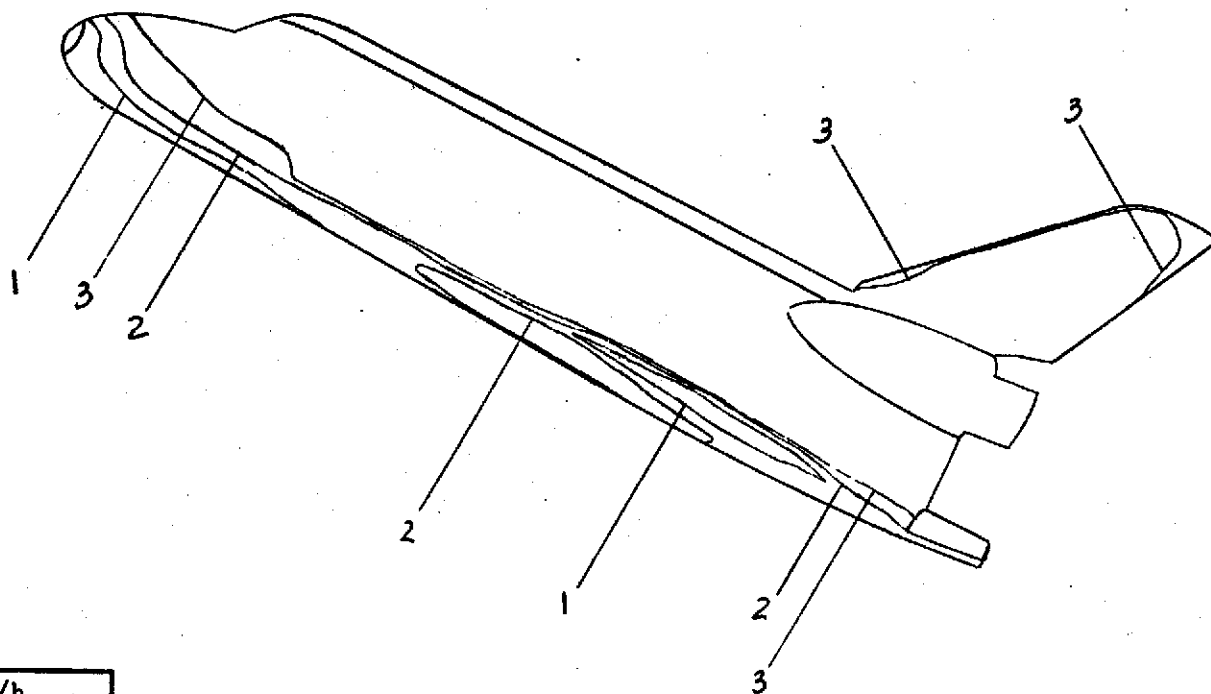
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.1443
2	.0833
3	.0450
4	
5	
6	
7	
8	
9	
10	

PAGE 71  
FIGURE 45

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3790

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (°R)} = 1385$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

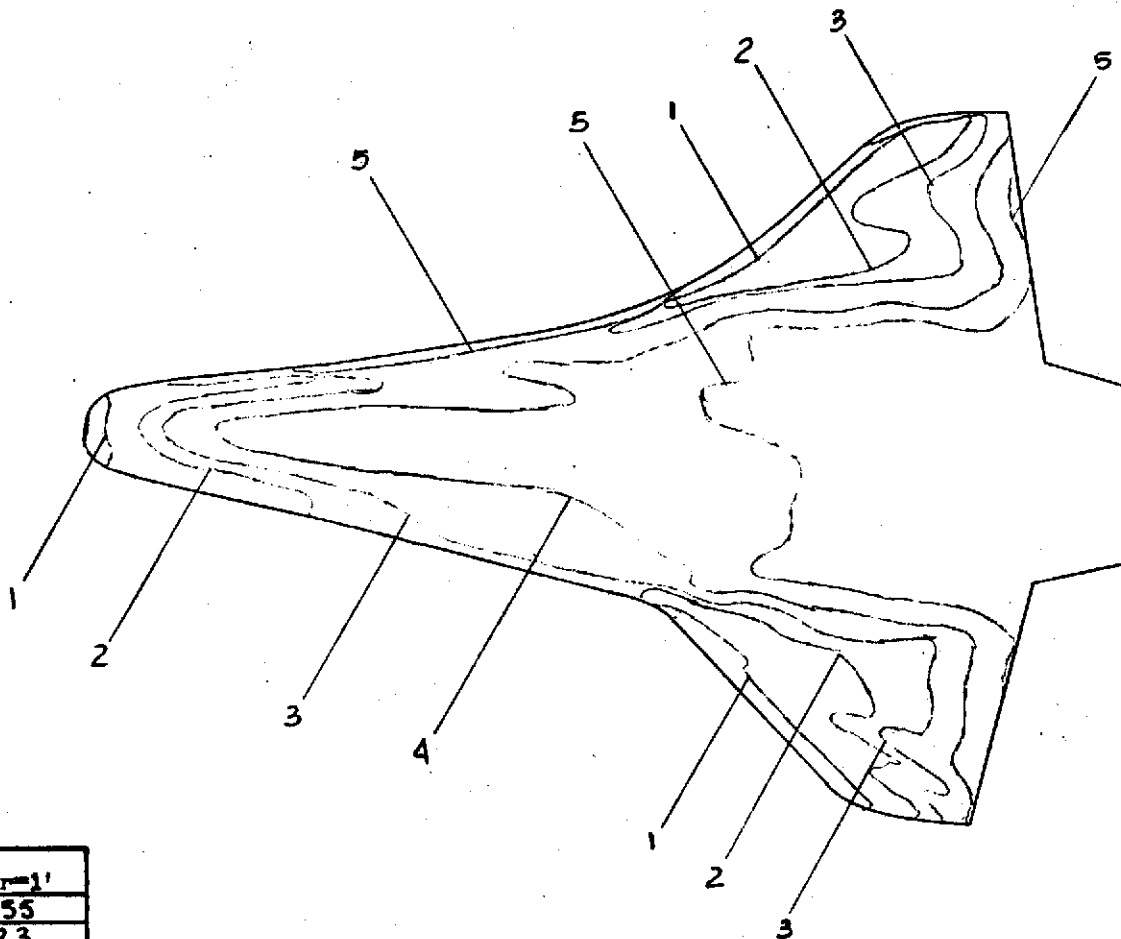
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2235
2	.1223
3	.0989
4	.0765
5	.0618
6	
7	
8	
9	
10	

PAGE 72  
FIGURE 46

CONFIG.

2

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3791

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^\circ\text{R)} = 1275$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 182$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

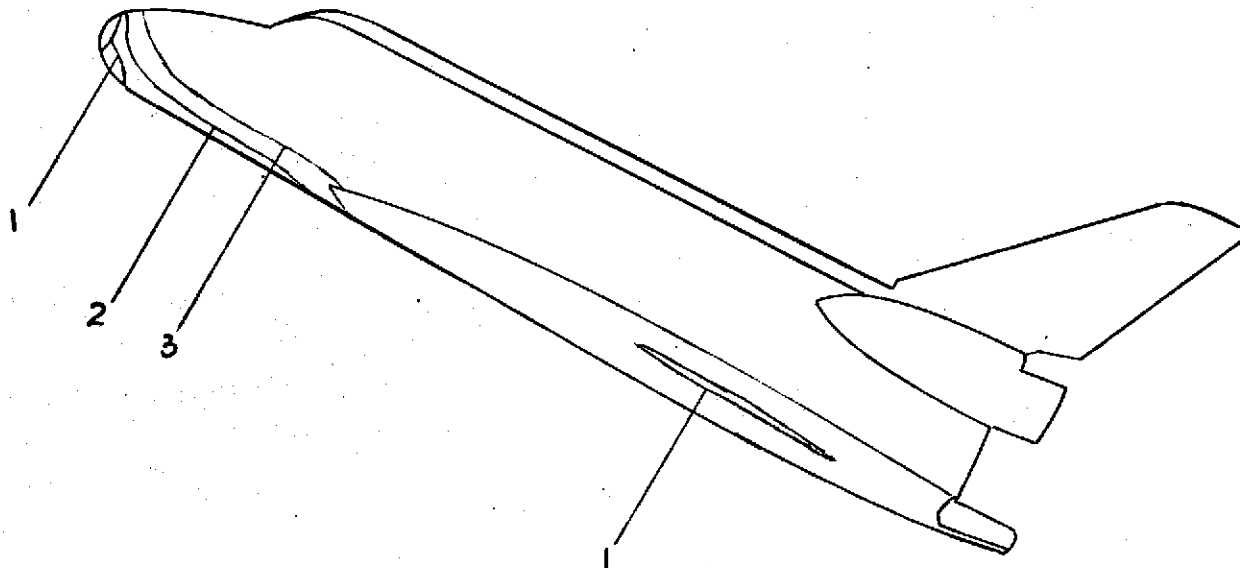
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.2310
2	.1291
3	.0631
4	
5	
6	
7	
8	
9	
10	

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FIGURE 47

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3791

$M_\infty = 7.9$

$P_{\text{total}} \text{ (psia)} = 174.7$

$T_{\text{total}} \text{ (}^\circ\text{R)} = 1275$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 182$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

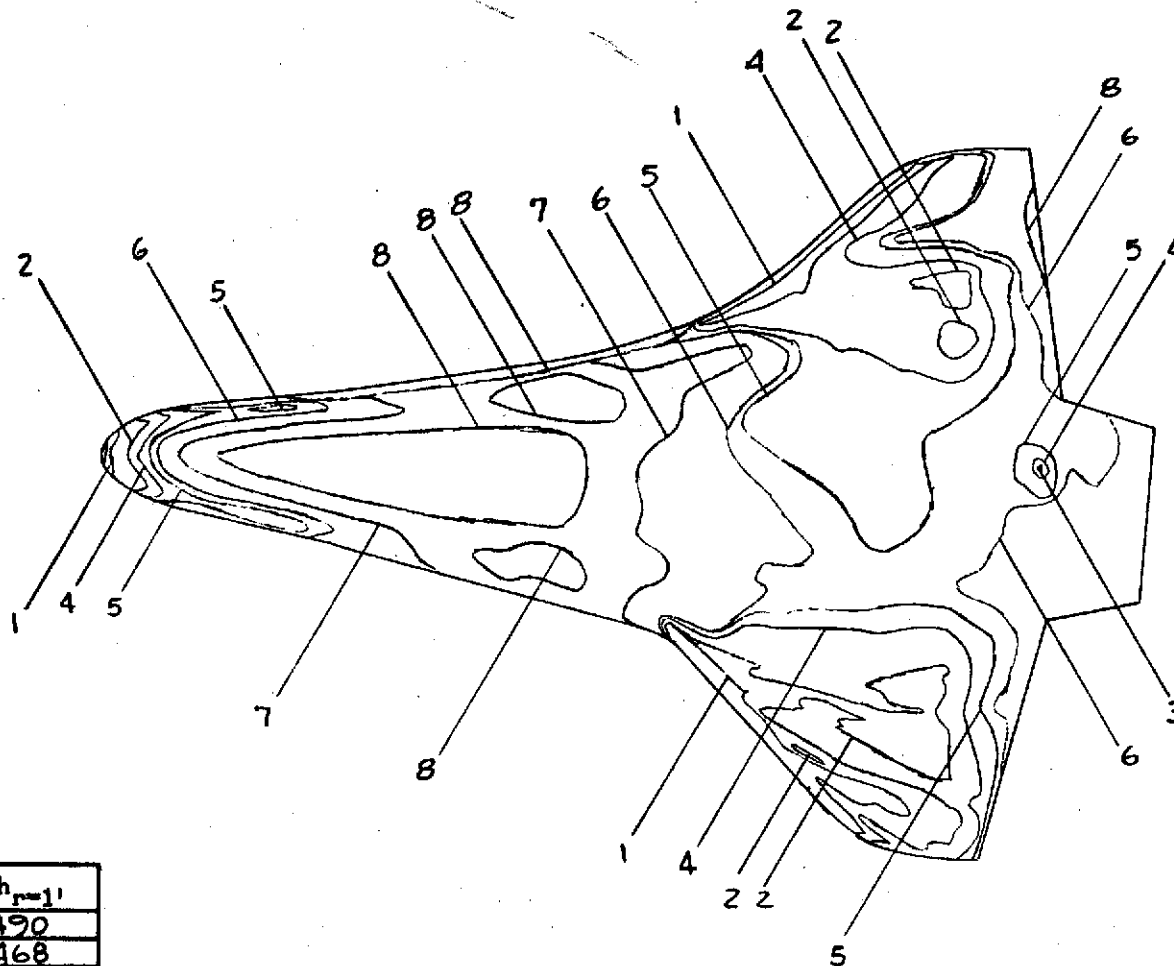
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.3490
2	.2468
3	.2015
4	.1979
5	.1699
6	.1544
7	.1234
8	.1008
9	
10	

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FIGURE 48

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3792

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (}^\circ\text{R)} = 1405$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

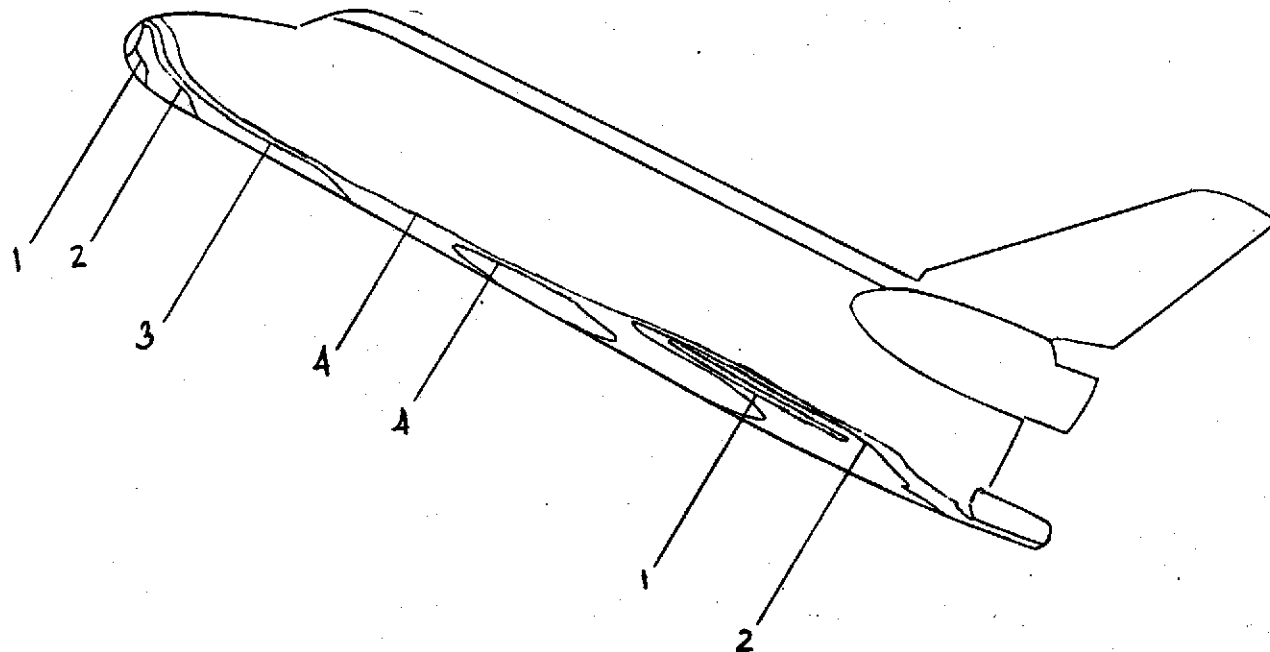
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3416
2	.1881
3	.1543
4	.1108
5	
6	
7	
8	
9	
10	

PAGE 75  
FIGURE 49

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3792

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (}^\circ\text{R)} = 1405$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

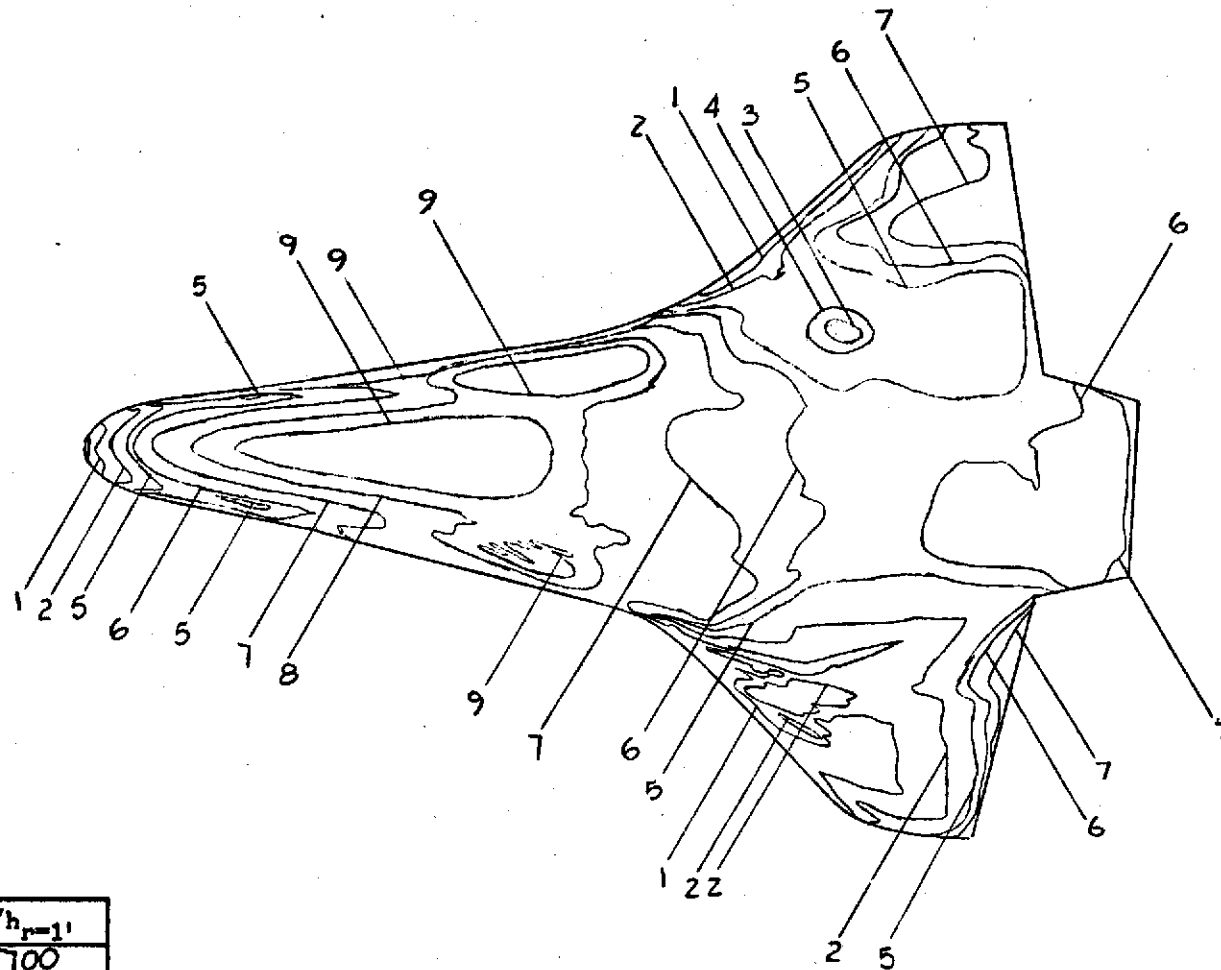
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3700
2	.2702
3	.2538
4	.2467
5	.2033
6	.1850
7	.1466
8	.1149
9	.1002
10	

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FIGURE 50

CONFIG.

4

LENGTH (ft) =

SCALE 006

FACILITY LRC-VDT

TEST

RUN 3793

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1410$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

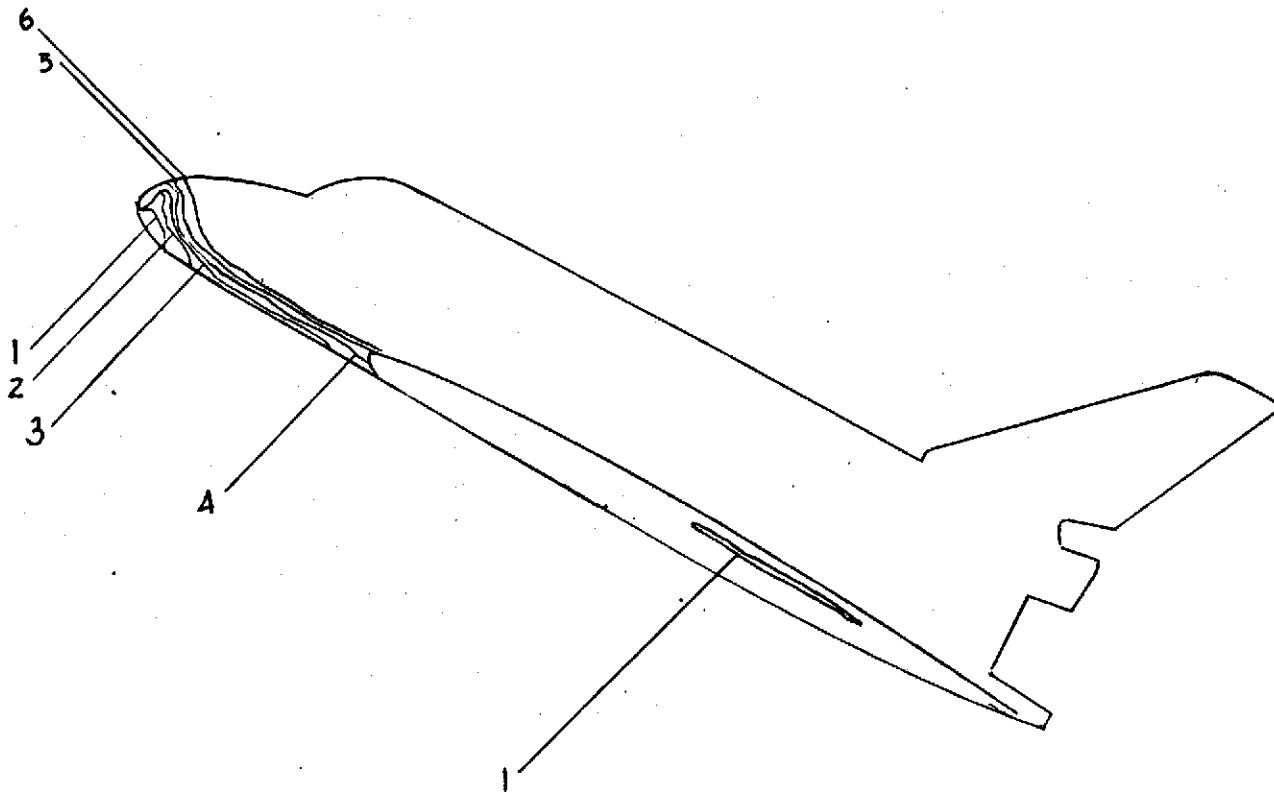
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3459
2	.2265
3	.1825
4	.1530
5	.1259
6	.1038
7	
8	
9	
10	

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FIGURE 51

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3793

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (°R)} = 1410$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

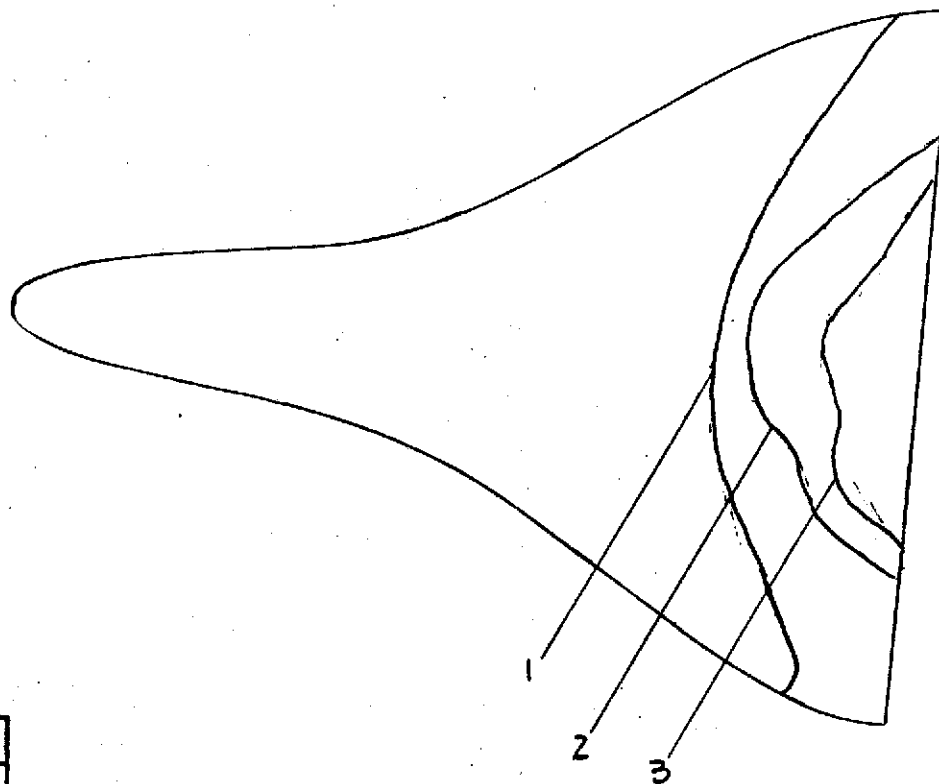
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.1292
2	.0621
3	.0554
4	
5	
6	
7	
8	
9	
10	

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FIGURE 52

CONFIG.

110D

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3794

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 634.7$

$T_{total} \text{ (°R)} = 1385$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 150$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

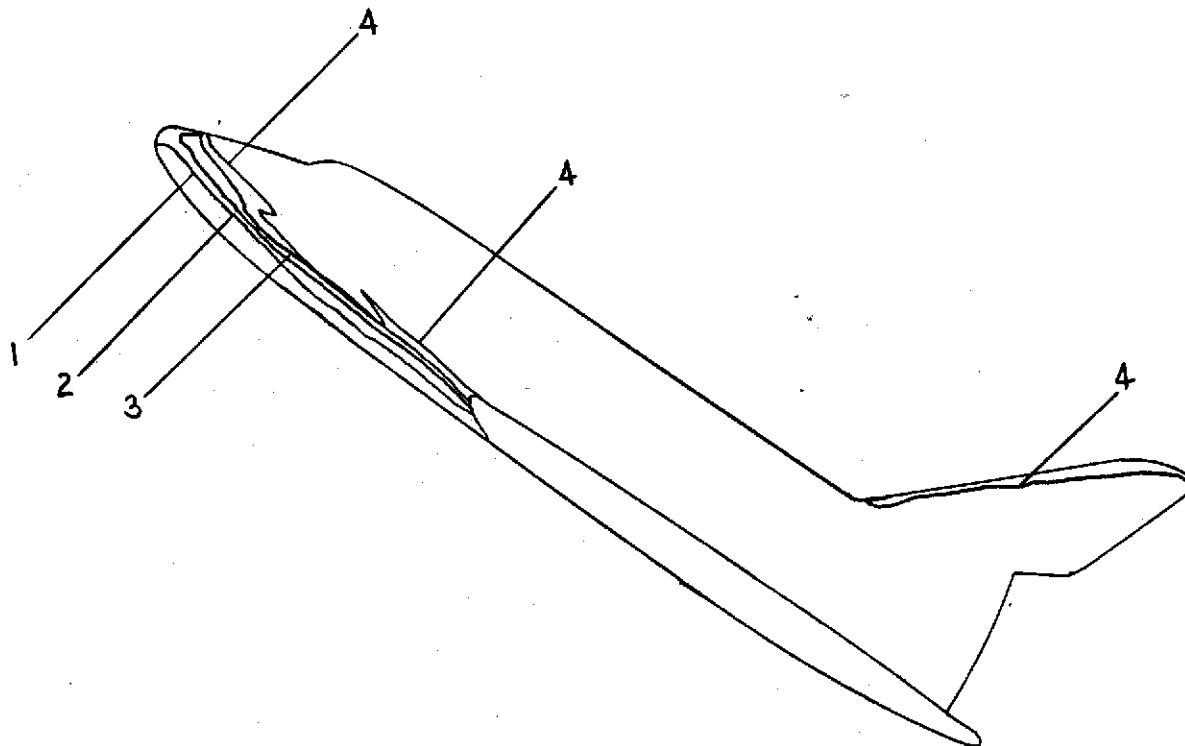
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.0803
2	.0408
3	.0293
4	.0207
5	
6	
7	
8	
9	
10	

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FIGURE 53

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3794

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 634.7

$T_{total}$  ( $^{\circ}R$ ) = 1385

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 150

$\alpha = 35$

$\beta = 0$

$\phi = 180$

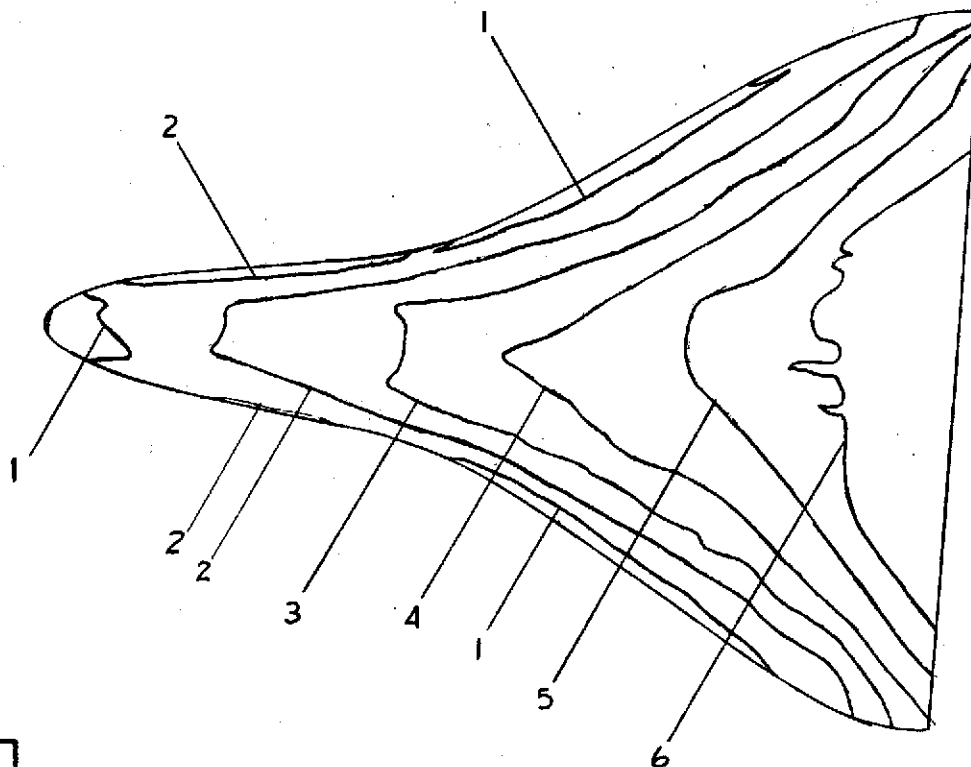
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2313
2	.1463
3	.1129
4	.0944
5	.0789
6	.0647
7	
8	
9	
10	

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FIGURE 54

CONFIG.

1100

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3795

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (°R)} = 1390$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

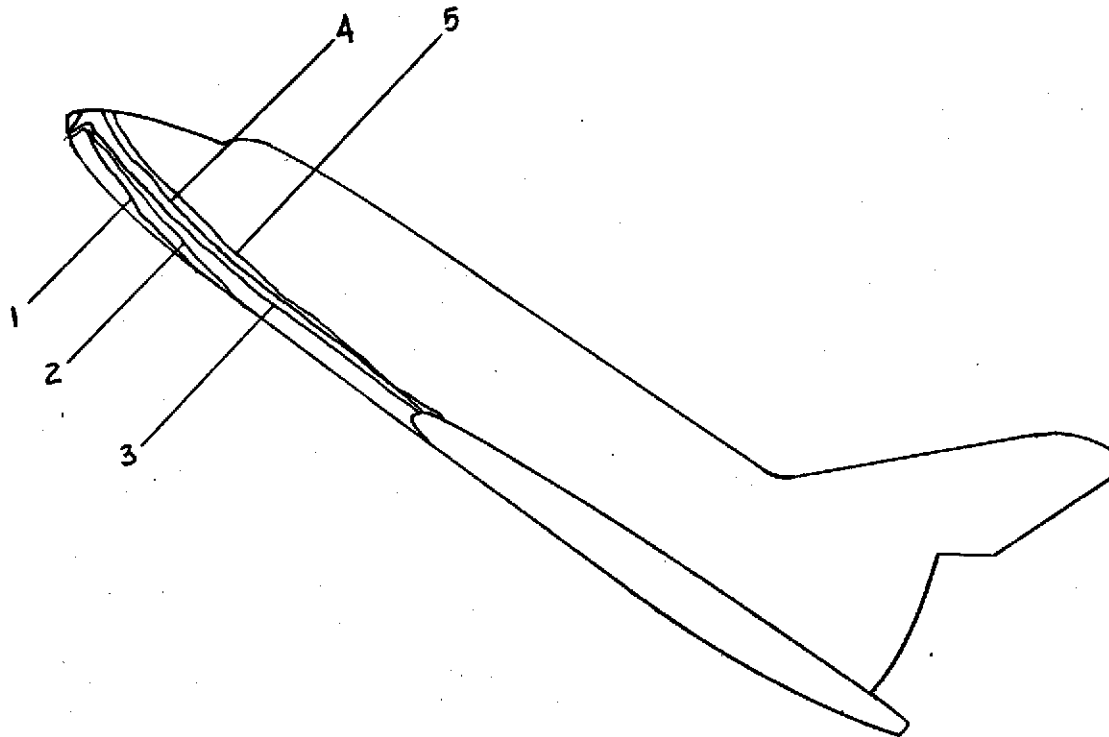
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1398
2	.1042
3	.0807
4	.0514
5	.0397
6	
7	
8	
9	
10	

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FIGURE 55

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3795

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (°R)} = 1390$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

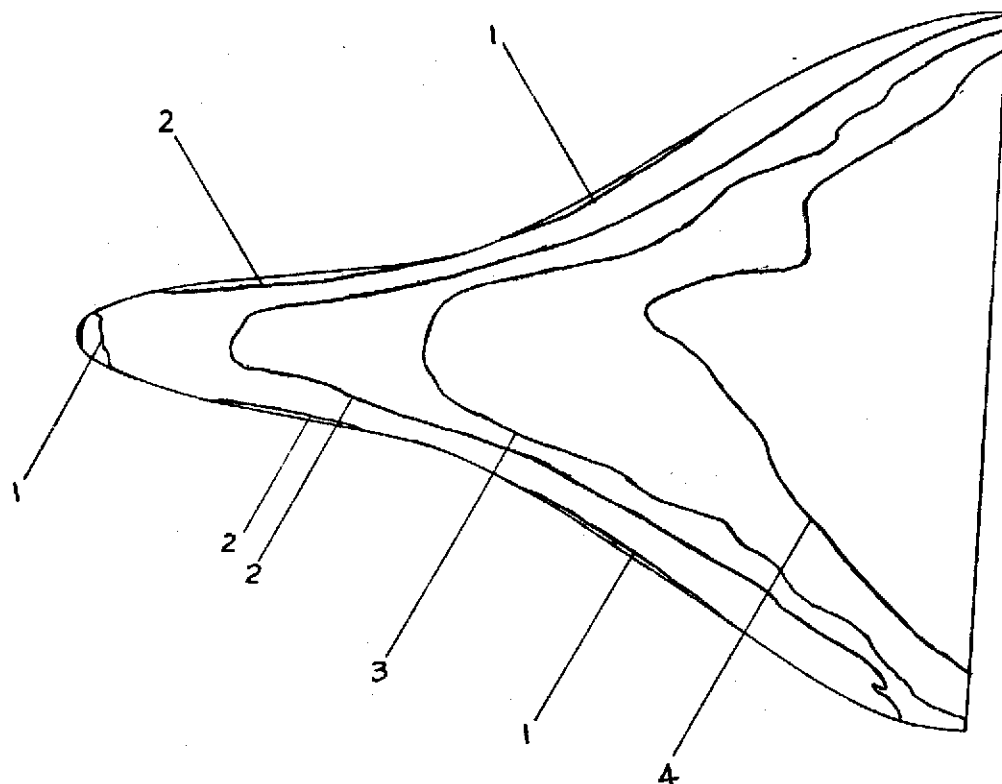
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3202
2	.1527
3	.1162
4	.0899
5	
6	
7	
8	
9	
10	

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FIGURE 56

CONFIG.

#10D

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3796

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1390$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 250$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

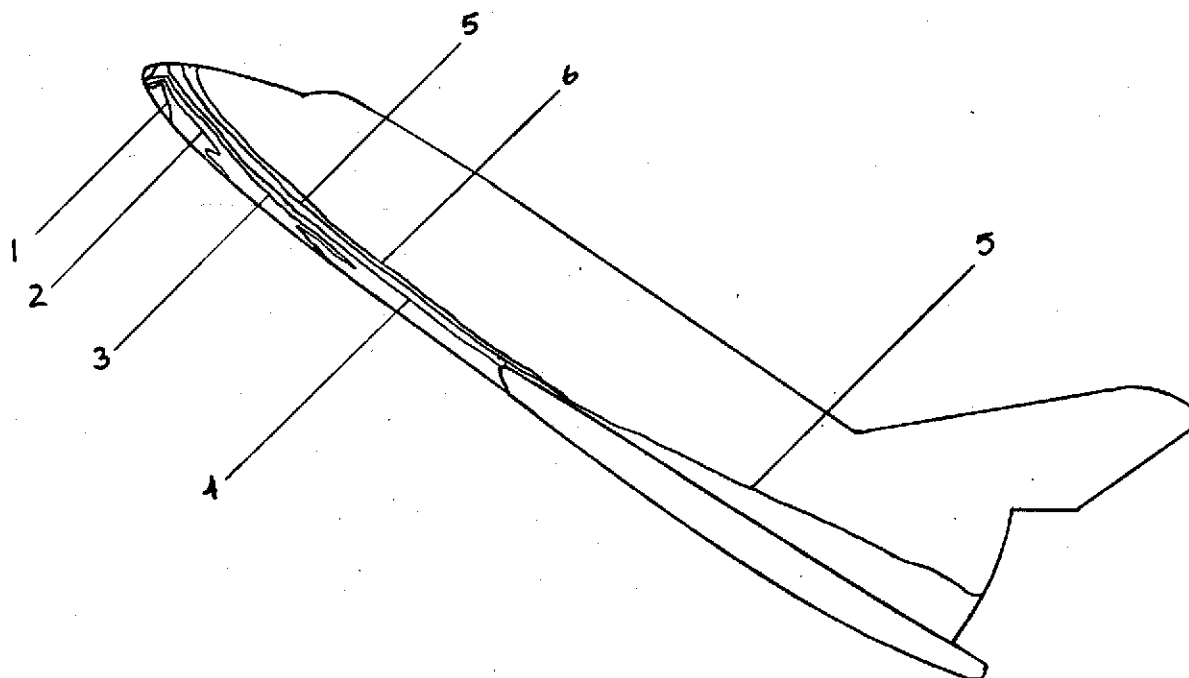
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.1974
2	.1526
3	.1040
4	.0883
5	.0685
6	.0570
7	
8	
9	
10	

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FIGURE 57

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3796

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1390$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 250$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

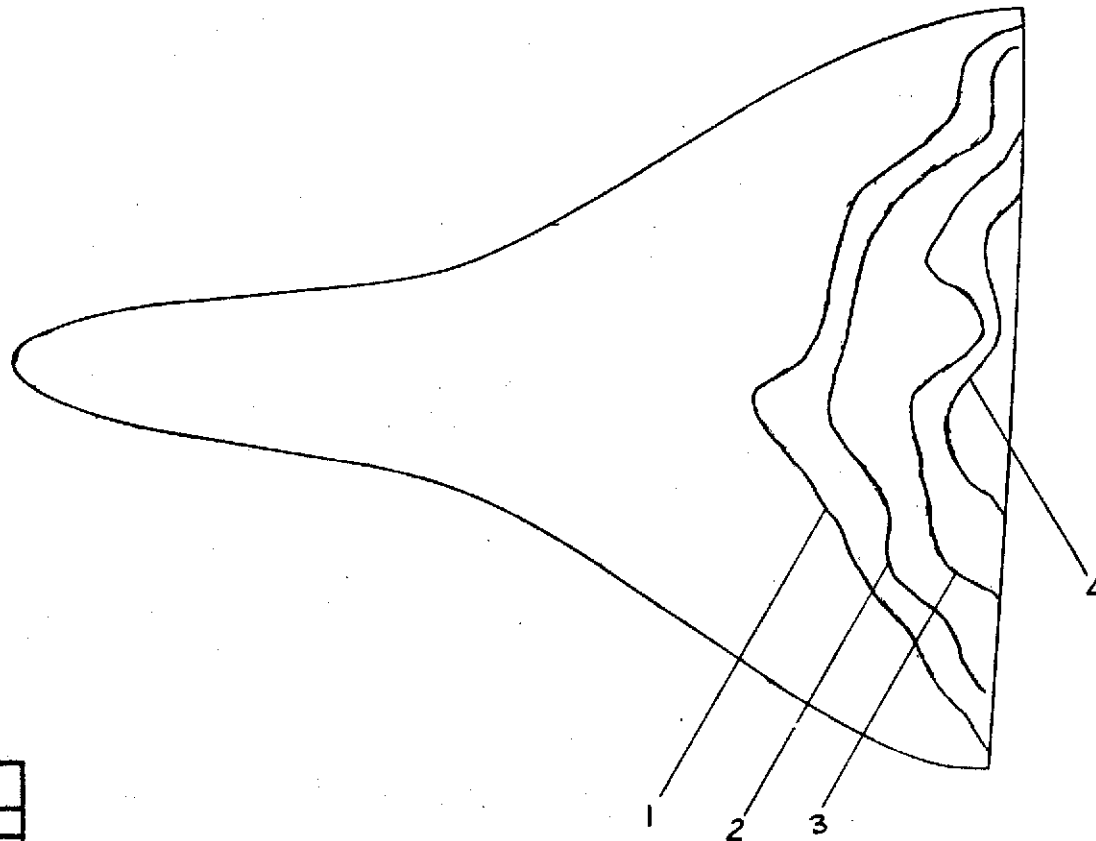
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0771
2	.0616
3	.0499
4	.0442
5	
6	
7	
8	
9	
10	

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FIGURE 58

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3797

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (°R)} = 1390$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

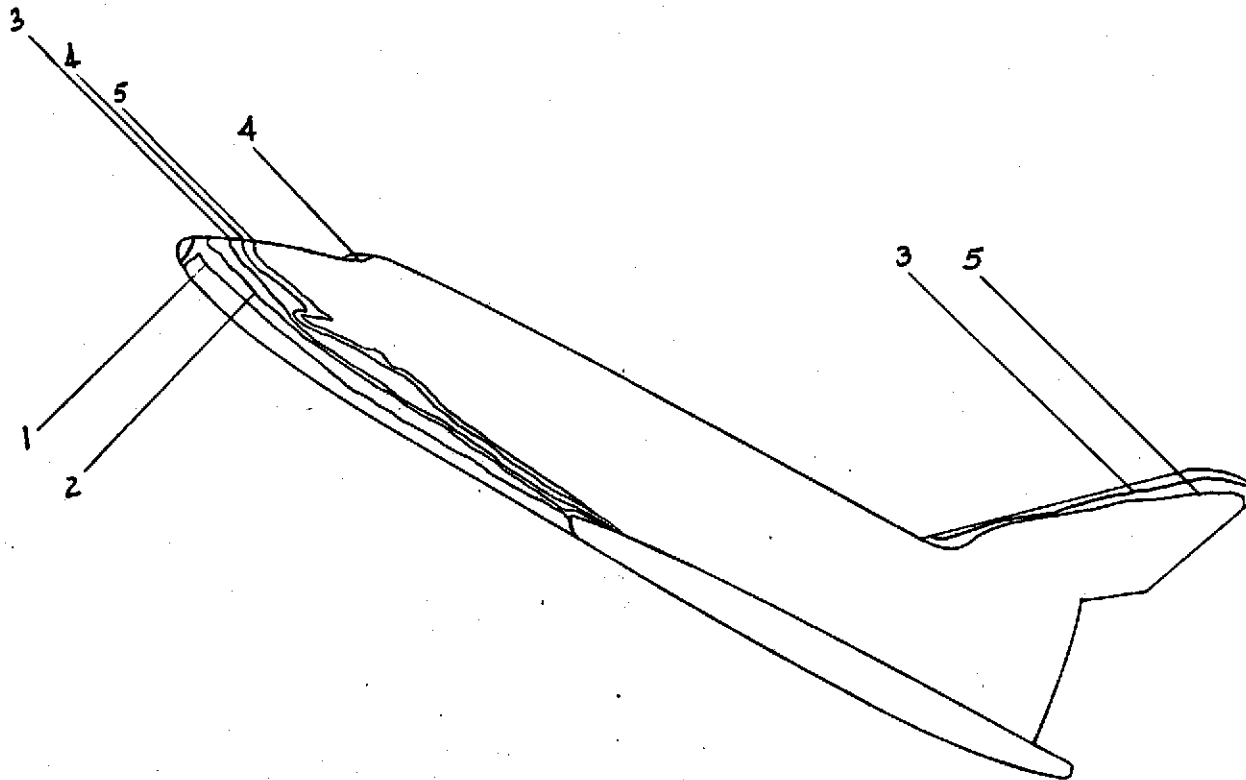
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0802
2	.0463
3	.0306
4	.0234
5	.0194
6	
7	
8	
9	
10	

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FIGURE 59

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3797

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (}^\circ\text{R)} = 1390$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

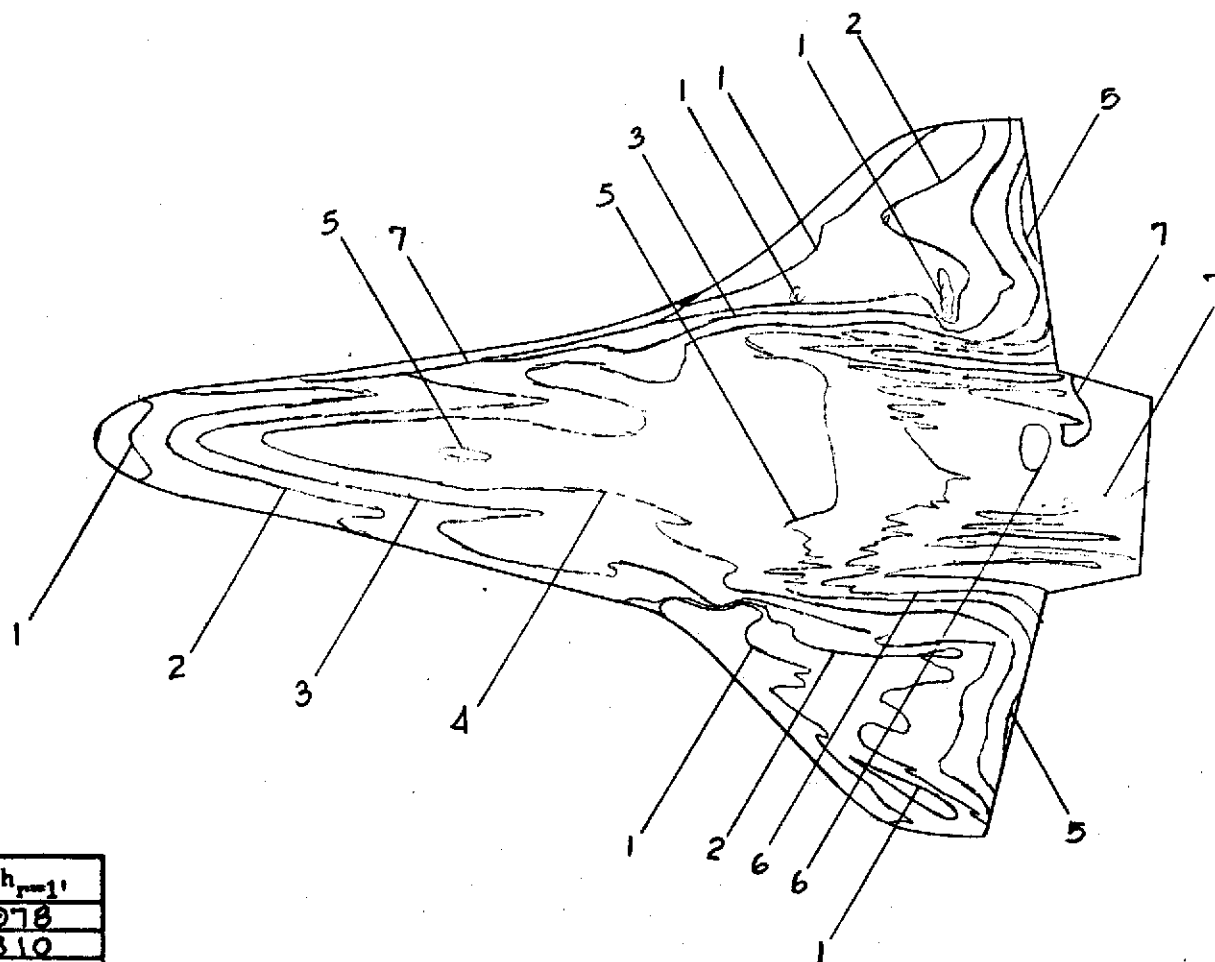
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1978
2	.1310
3	.1026
4	.0849
5	.0740
6	.0665
7	.0596
8	
9	
10	

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FIGURE 60

CONFIG.

3

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3798

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 544.7

$T_{total}$  ( $^{\circ}R$ ) = 1360

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

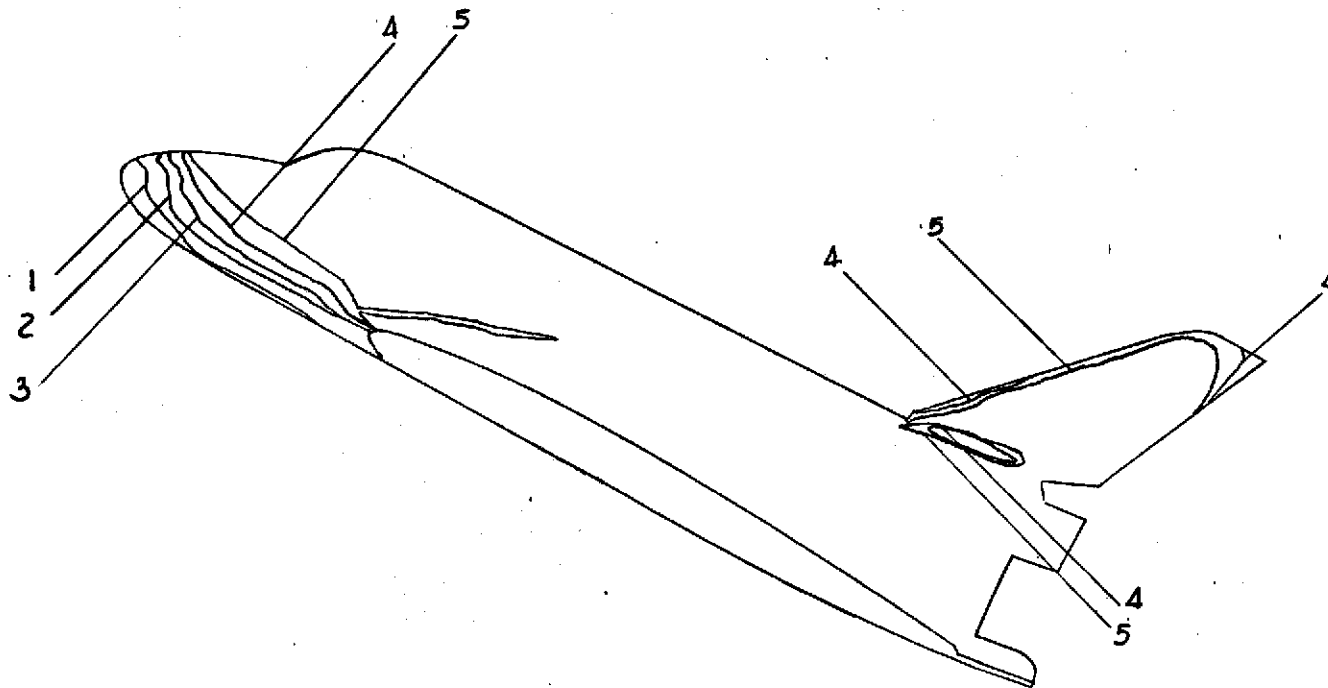
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1678
2	.1083
3	.0750
4	.0593
5	.0484
6	
7	
8	
9	
10	

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FIGURE 61

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3798

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 544.7$

$T_{total} \text{ (}^\circ\text{R)} = 1360$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

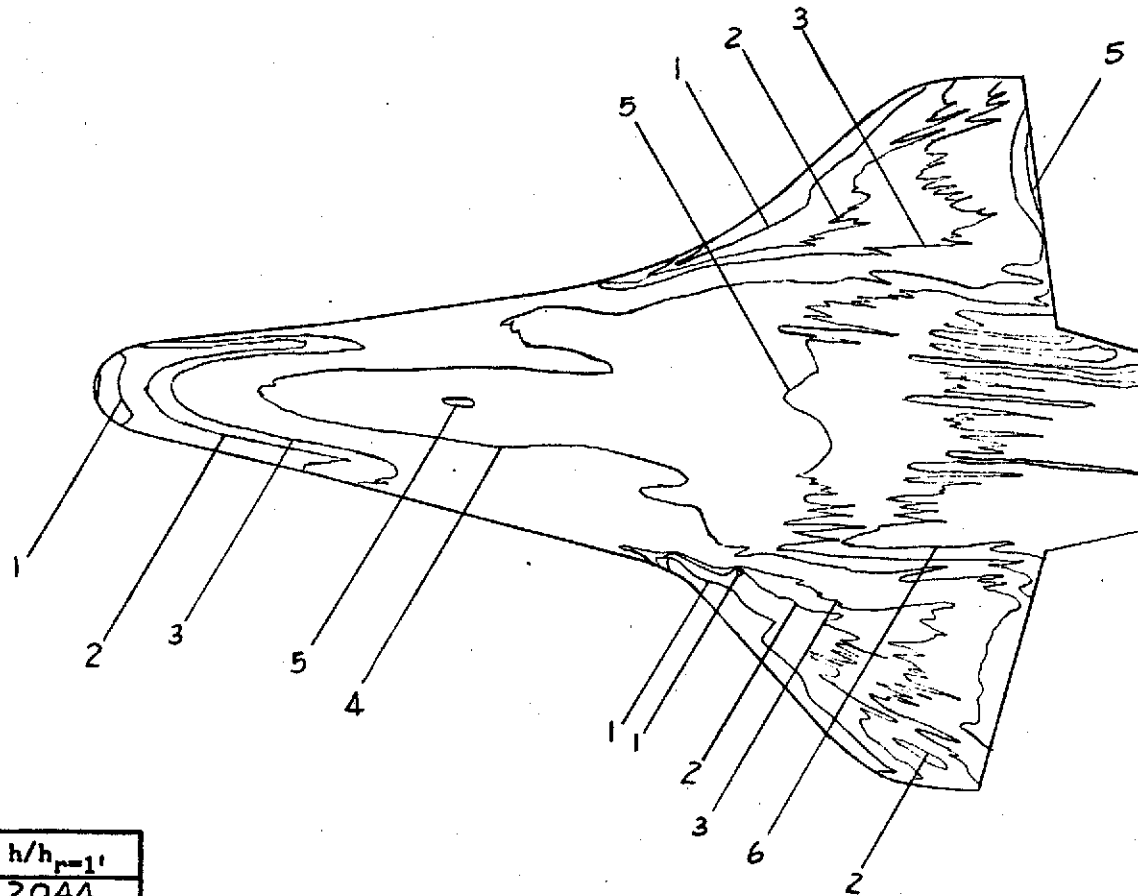
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1'}$
1	.2044
2	.1445
3	.1180
4	.0826
5	.0686
6	.0593
7	
8	
9	
10	

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FIGURE 62

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3799

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 464.7$

$T_{total} \text{ (}^\circ\text{R)} = 1340$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

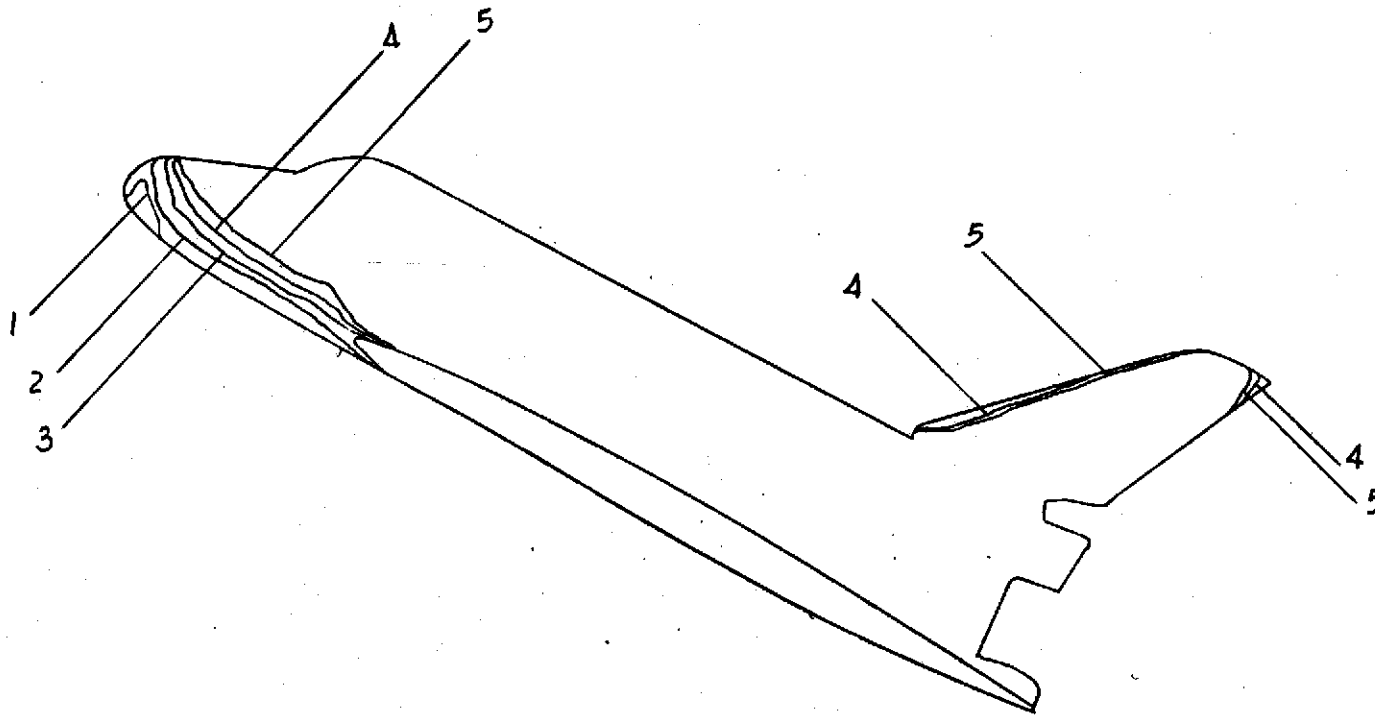
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2216
2	.1311
3	.0829
4	.0618
5	.0524
6	
7	
8	
9	
10	

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FIGURE 63

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3799

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 464.7$

$T_{total} \text{ (°R)} = 1340$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

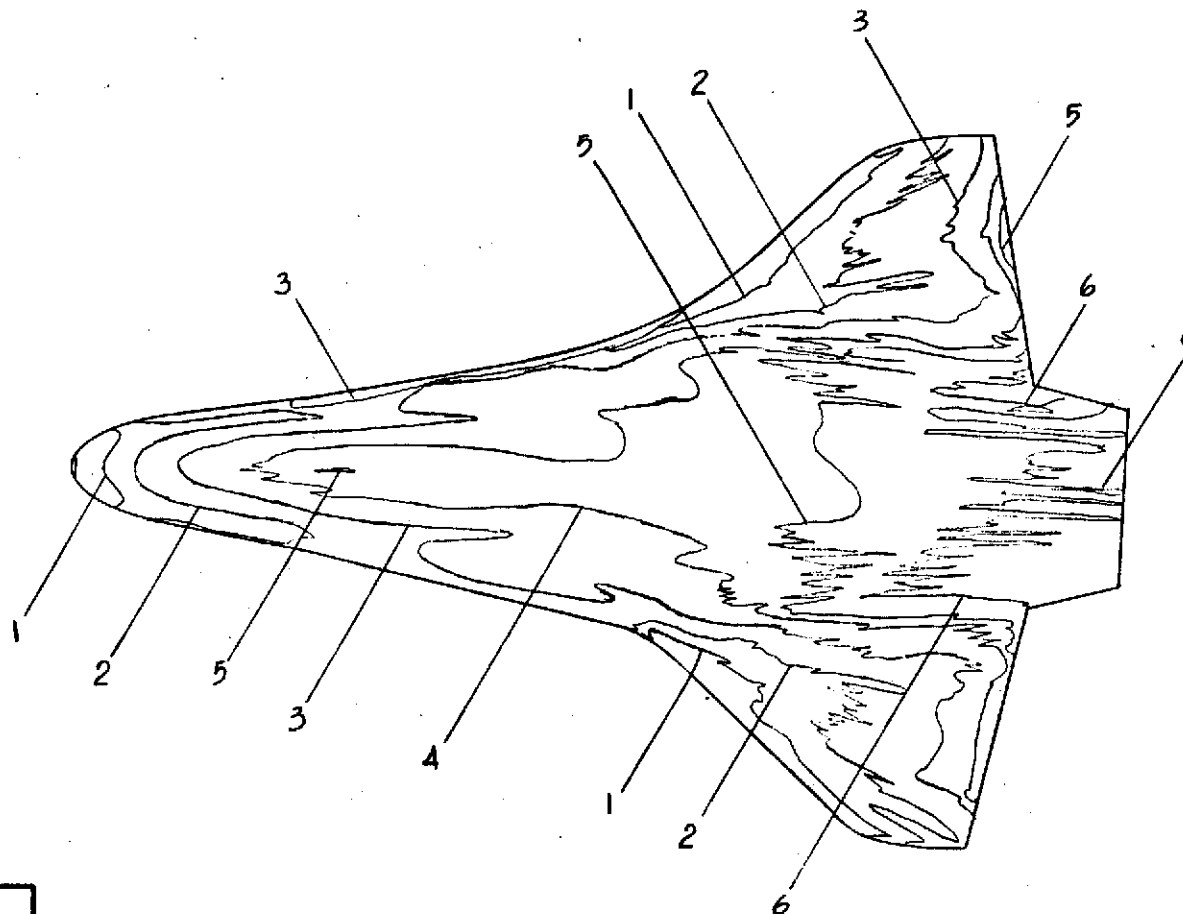
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.1948
2	.1299
3	.0931
4	.0724
5	.0624
6	.0516
7	
8	
9	
10	

PAGE 90  
FIGURE 64

CONFIG.

3

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3800

$M_\infty = 7.9$

$P_{total}$  (psia) = 464.7

$T_{total}$  (°R) = 1365

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

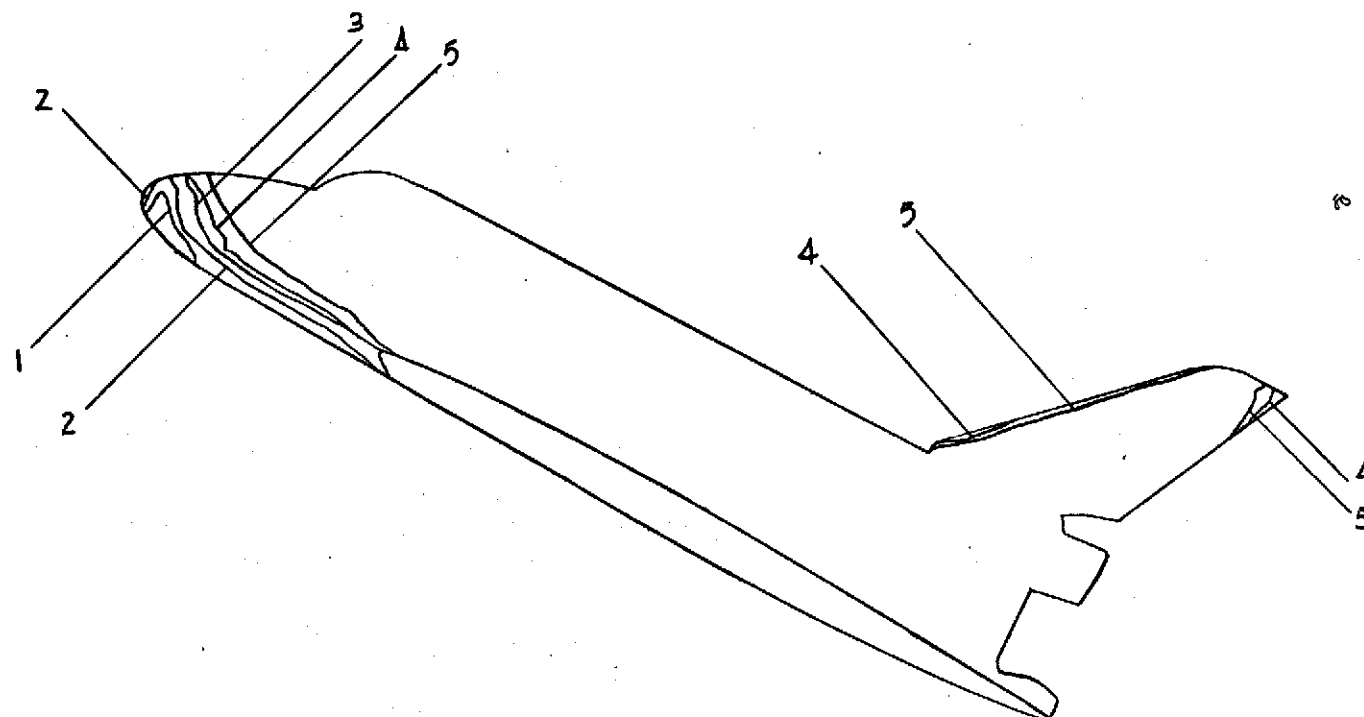
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2071
2	.1225
3	.0775
4	.0613
5	.0500
6	
7	
8	
9	
10	

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FIGURE 65

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3800

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 464.7$

$T_{total} \text{ (°R)} = 1365$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

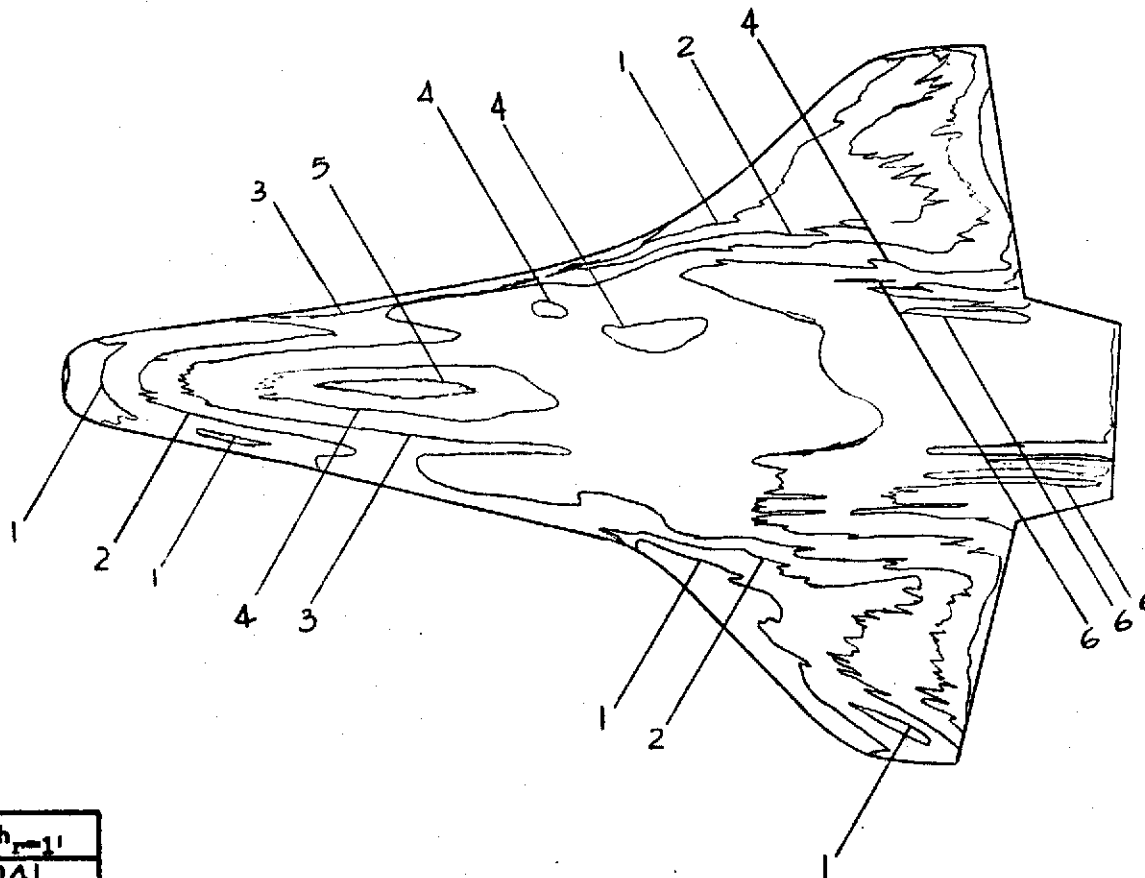
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1741
2	.1231
3	.0953
4	.0706
5	.0674
6	.0603
7	
8	
9	
10	

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FIGURE 66

CONFIG.

2

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3802

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 539.7$

$T_{total} \text{ (°R)} = 1345$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

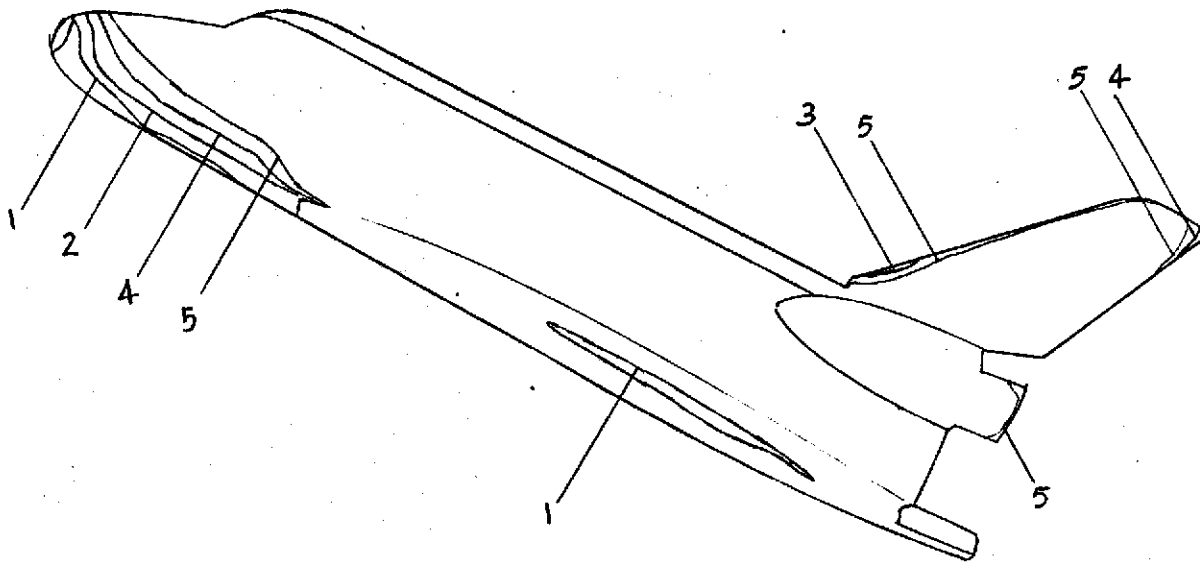
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.1669
2	.0963
3	.0778
4	.0635
5	.0470
6	
7	
8	
9	
10	

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FIGURE 67

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3802

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 539.7$

$T_{total} \text{ (}^\circ\text{R)} = 1345$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

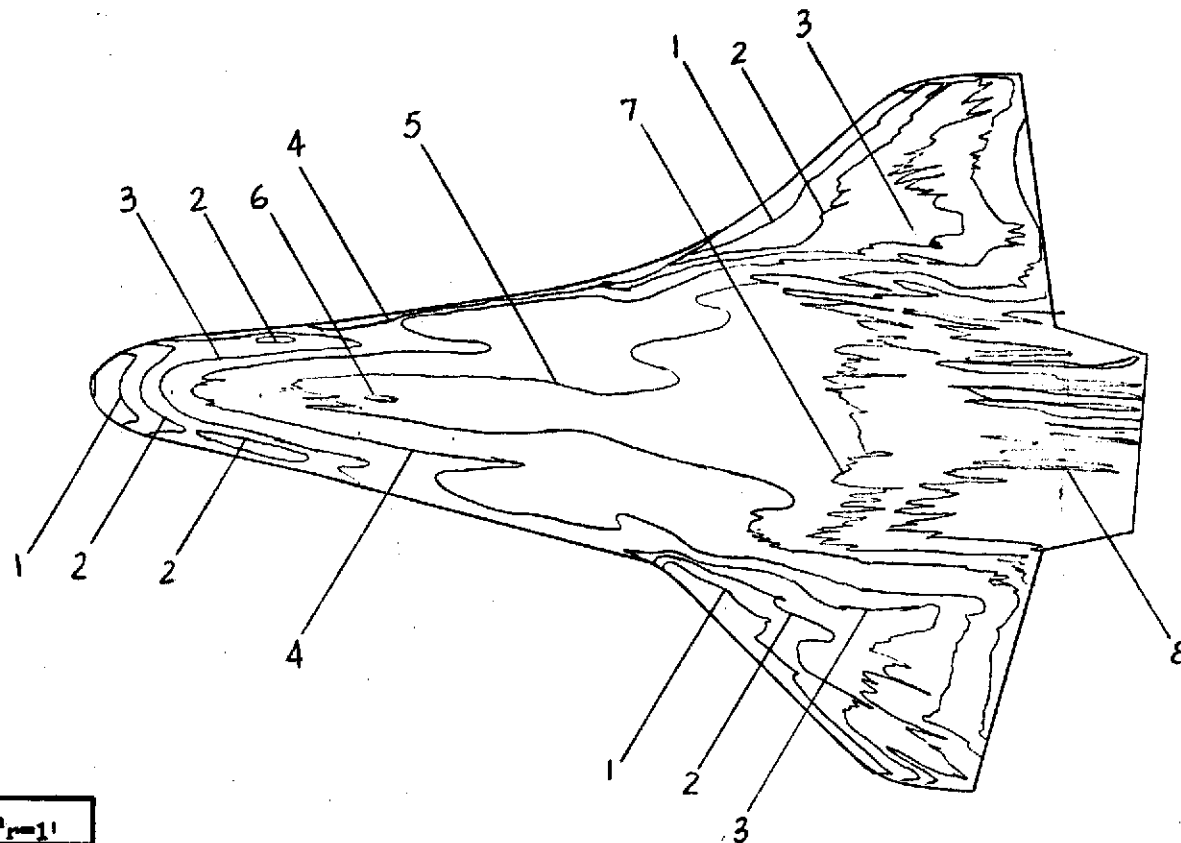
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.2105
2	.1537
3	.1191
4	.0953
5	.0727
6	.0653
7	.0624
8	.0528
9	
10	

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FIGURE 68

CONFIG.  
3

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3803

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 429.7$

$T_{total} \text{ (}^\circ\text{R)} = 1340$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

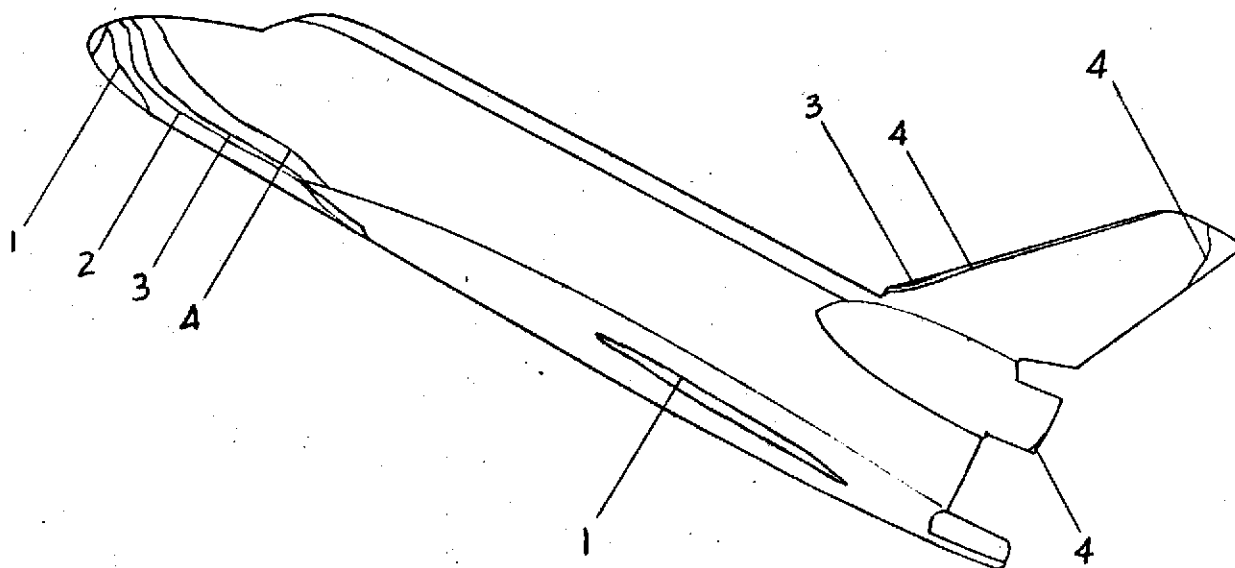
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.1909
2	.1208
3	.0837
4	.0538
5	
6	
7	
8	
9	
10	

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FIGURE 69

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3803

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 429.7$

$T_{total} \text{ (}^\circ\text{R)} = 1340$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

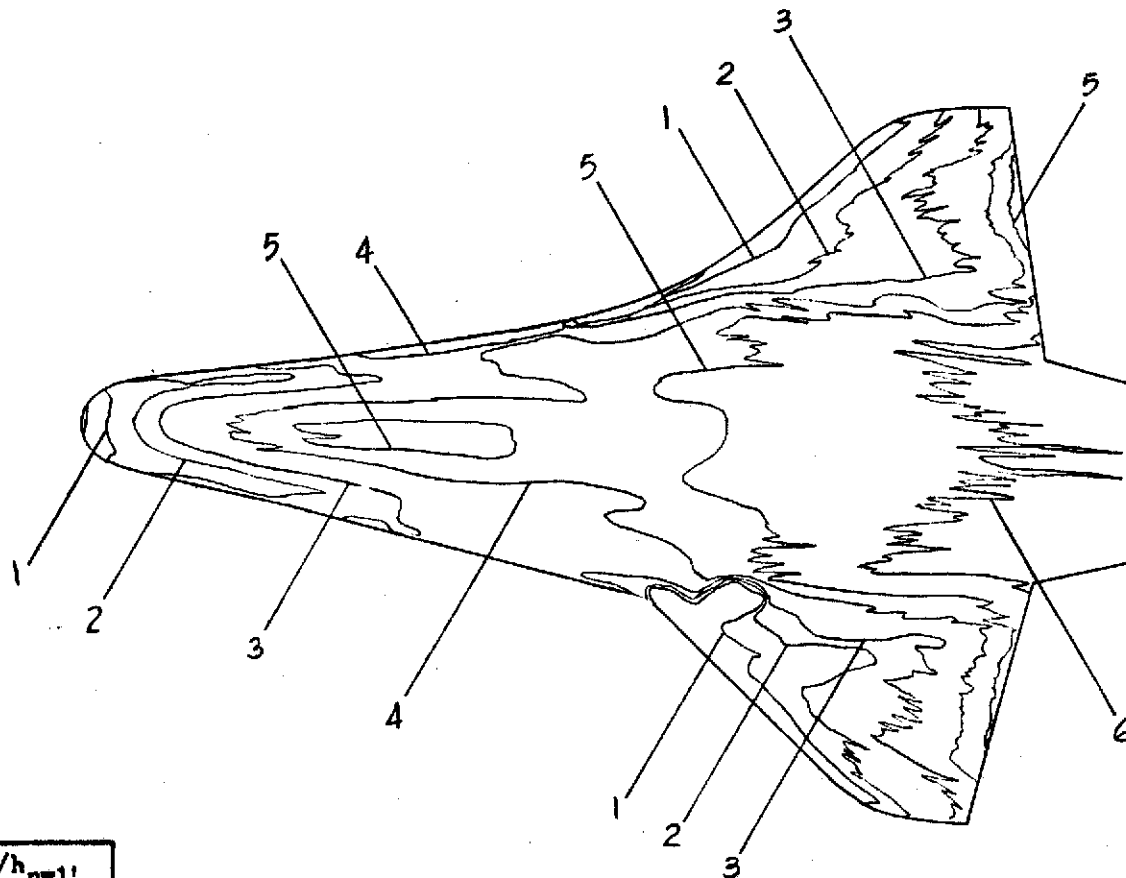
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1970
2	.1313
3	.1001
4	.0744
5	.0635
6	.0485
7	
8	
9	
10	

PAGE 96  
FIGURE 70

CONFIG.

2

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3804

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 424.7$

$T_{total} \text{ (°R)} = 1380$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

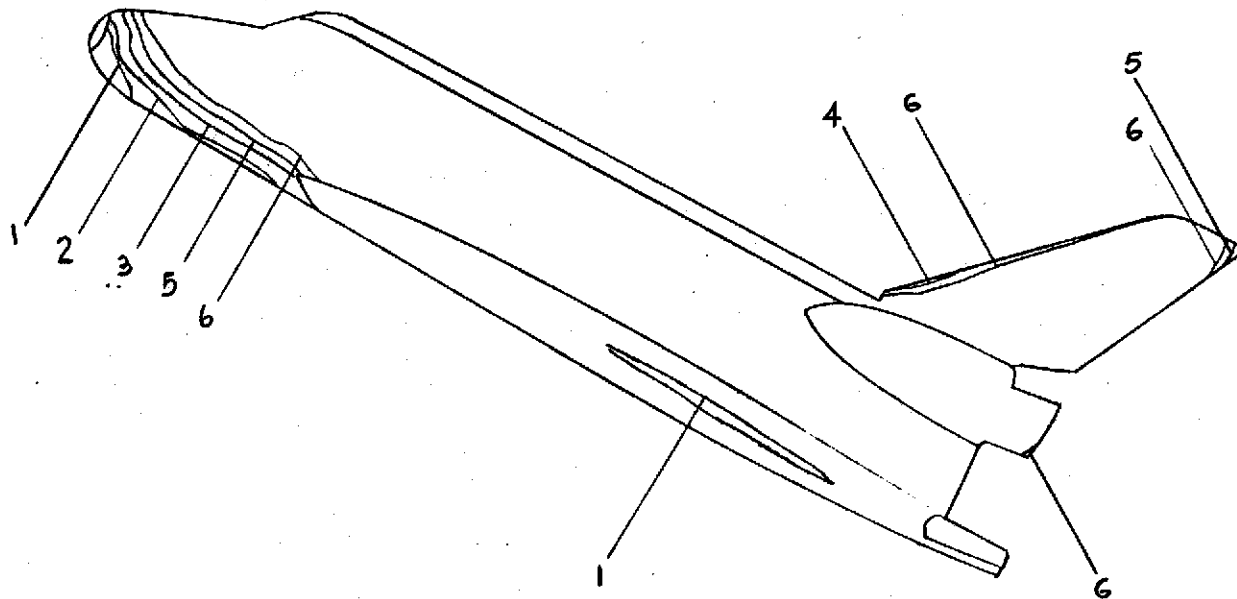
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{film}}$
1	.1785
2	.1458
3	.0916
4	.0776
5	.0616
6	.0493
7	
8	
9	
10	

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FIGURE 71

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3804

$M_\infty = 7.9$

$P_{\text{total}}$  (psia) = 424.7

$T_{\text{total}}$  ( $^{\circ}\text{R}$ ) = 1380

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N$  per foot =

$T_{\text{phase change}}$  ( $^{\circ}\text{F}$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

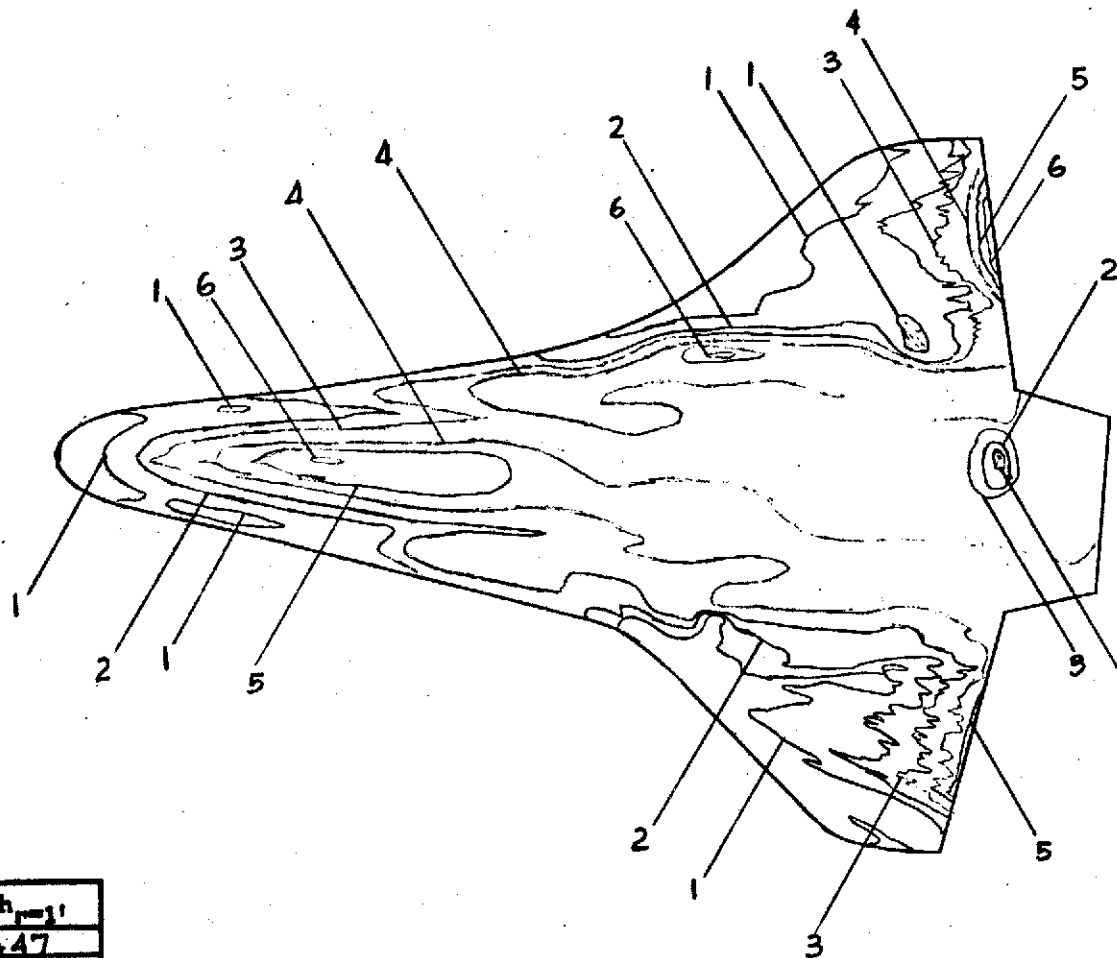
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1447
2	.1105
3	.0937
4	.0816
5	.0731
6	.0677
7	
8	
9	
10	

PAGE 98  
FIGURE 72

## CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3805

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 794.7$

$T_{total} \text{ (°R)} = 1420$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

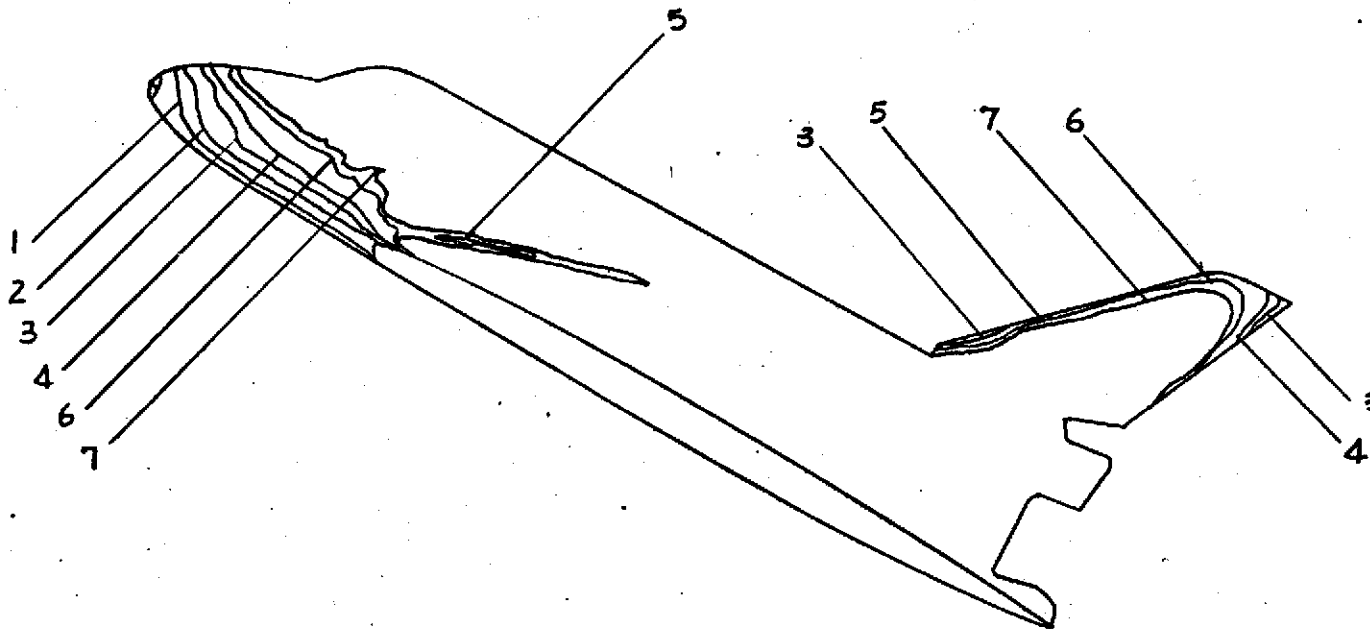
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1479
2	.1046
3	.0662
4	.0503
5	.0432
6	.0391
7	.0350
8	
9	
10	

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FIGURE 73

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3805

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 794.7$

$T_{total} \text{ (}^\circ\text{R)} = 1420$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

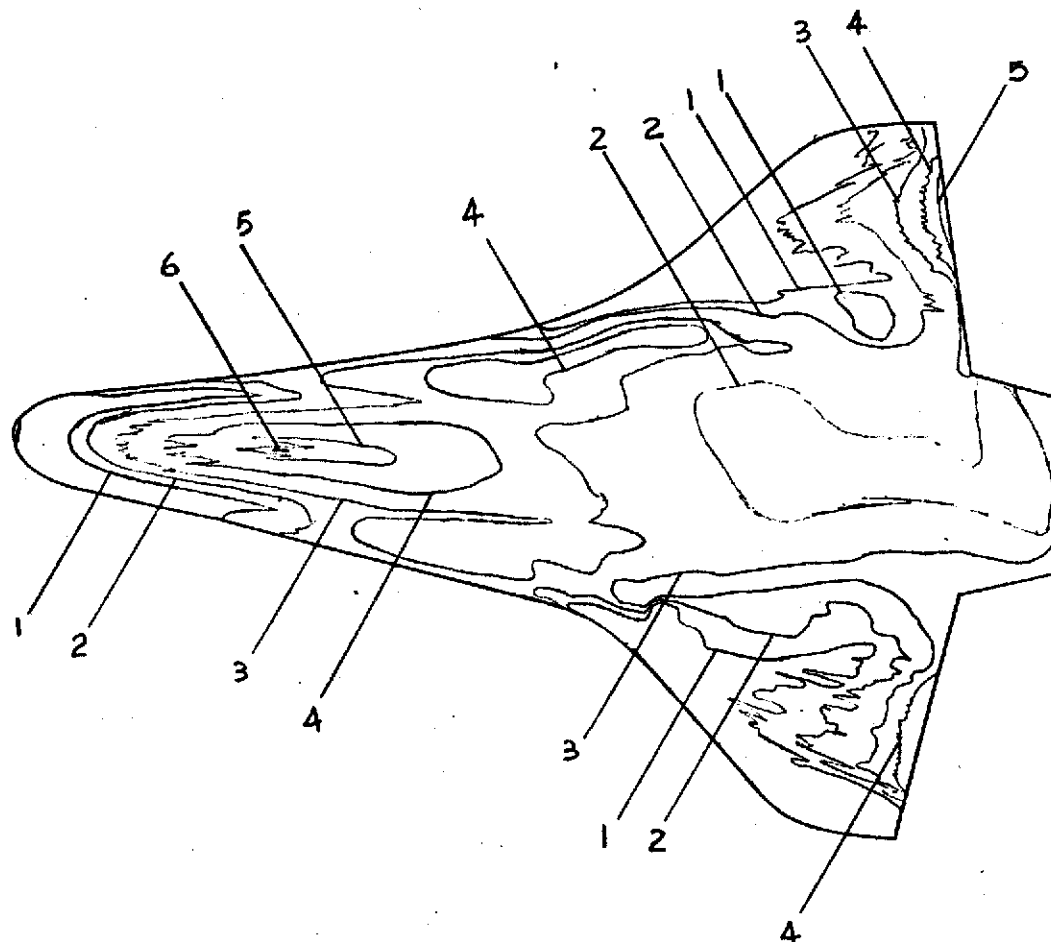
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.1291
2	.1038
3	.0913
4	.0769
5	.0661
6	.0631
7	
8	
9	
10	

PAGE 100

FIGURE 74

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3806

$M_\infty = 7.9$

$P_{total}$  (psia) = 774.7

$T_{total}$  ( $^{\circ}R$ ) = 1360

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

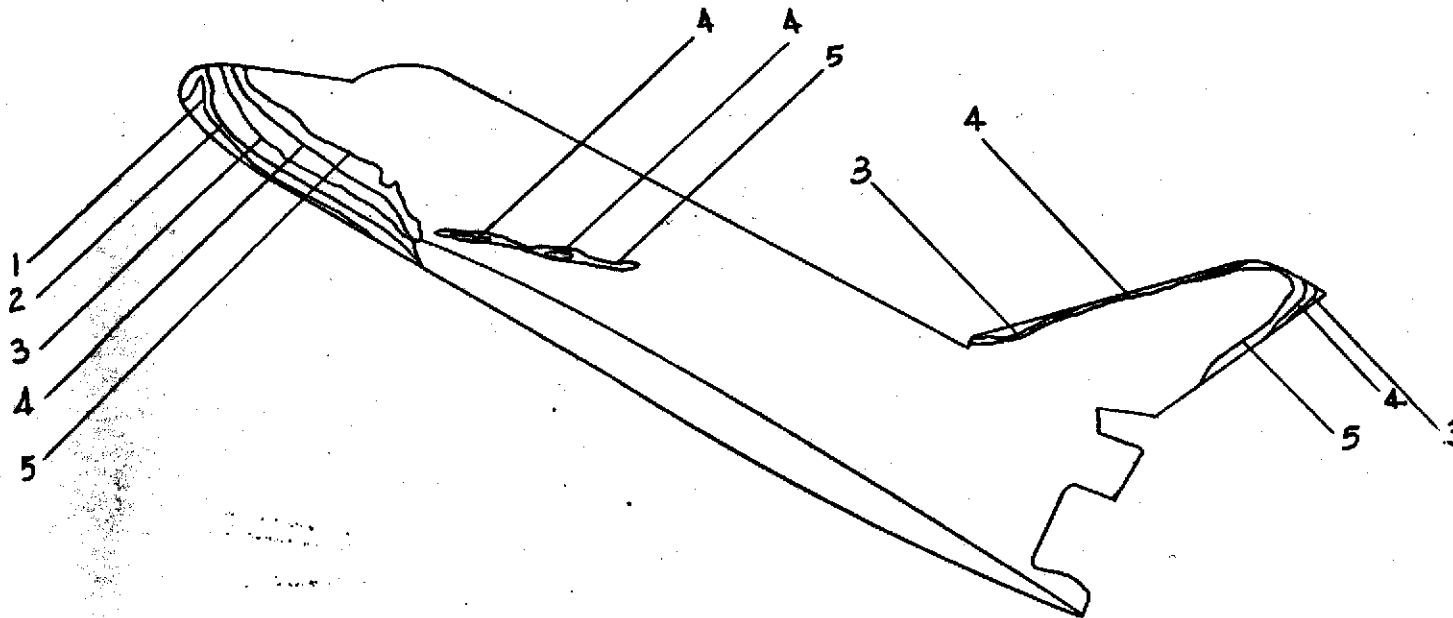
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.1656
2	.1171
3	.06197
4	.01619
5	.0384
6	
7	
8	
9	
10	

PAGE 101  
FIGURE 75

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3806

$M_\infty = 7.9$

$P_{total}$  (psia) = 774.7

$T_{total}$  ( $^{\circ}R$ ) = 1360

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 213

$\alpha = 30$

$\beta = 0$

$\phi = 180$

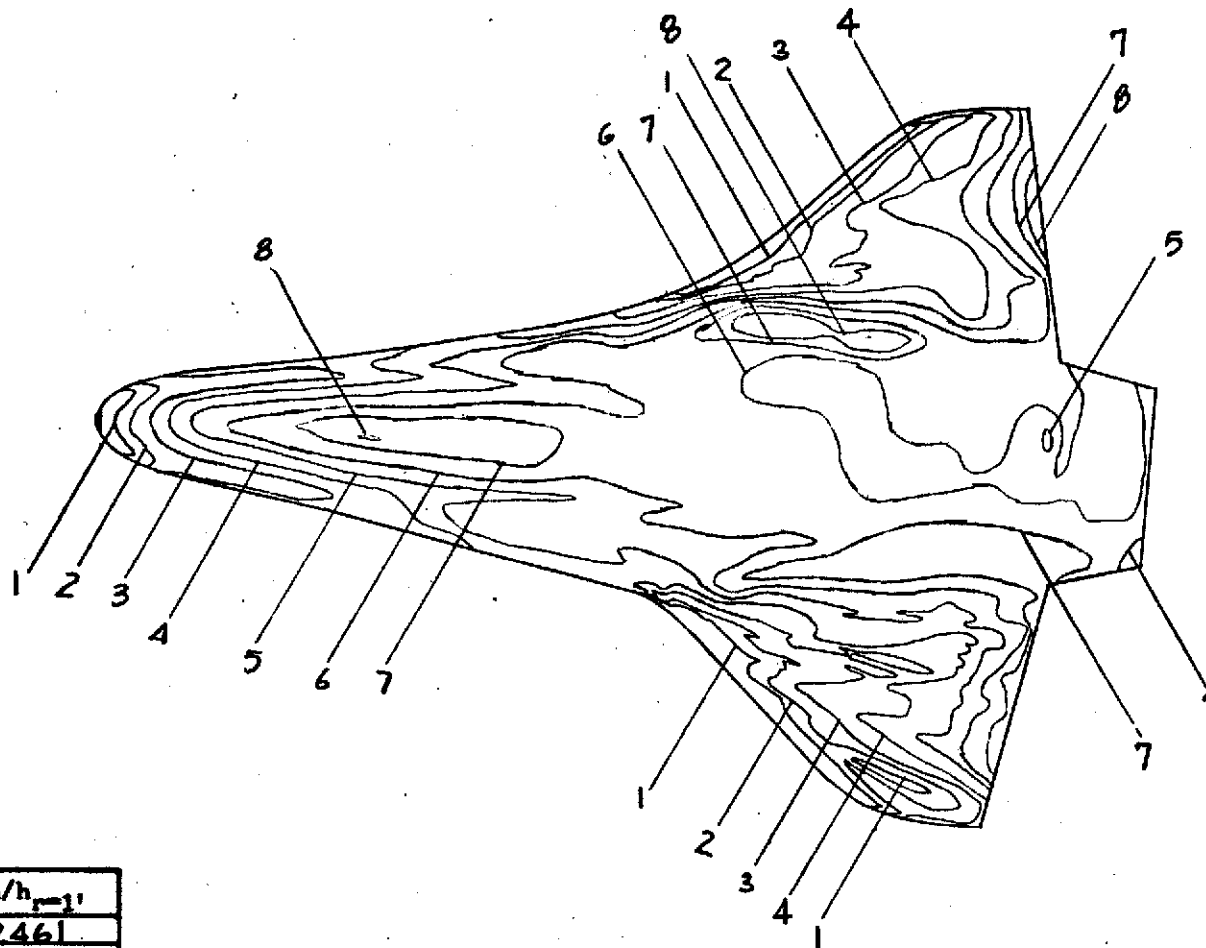
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.2461
2	.1887
3	.1421
4	.1160
5	.0996
6	.0859
7	.0759
8	.0696
9	
10	

PAGE 102  
FIGURE 76

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3807

$M_\infty = 7.9$

$P_{total}$  (psia) = 774.7

$T_{total}$  ( $^{\circ}R$ ) = 1390

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 300

$\alpha = 30$

$\beta = 0$

$\phi = 180$

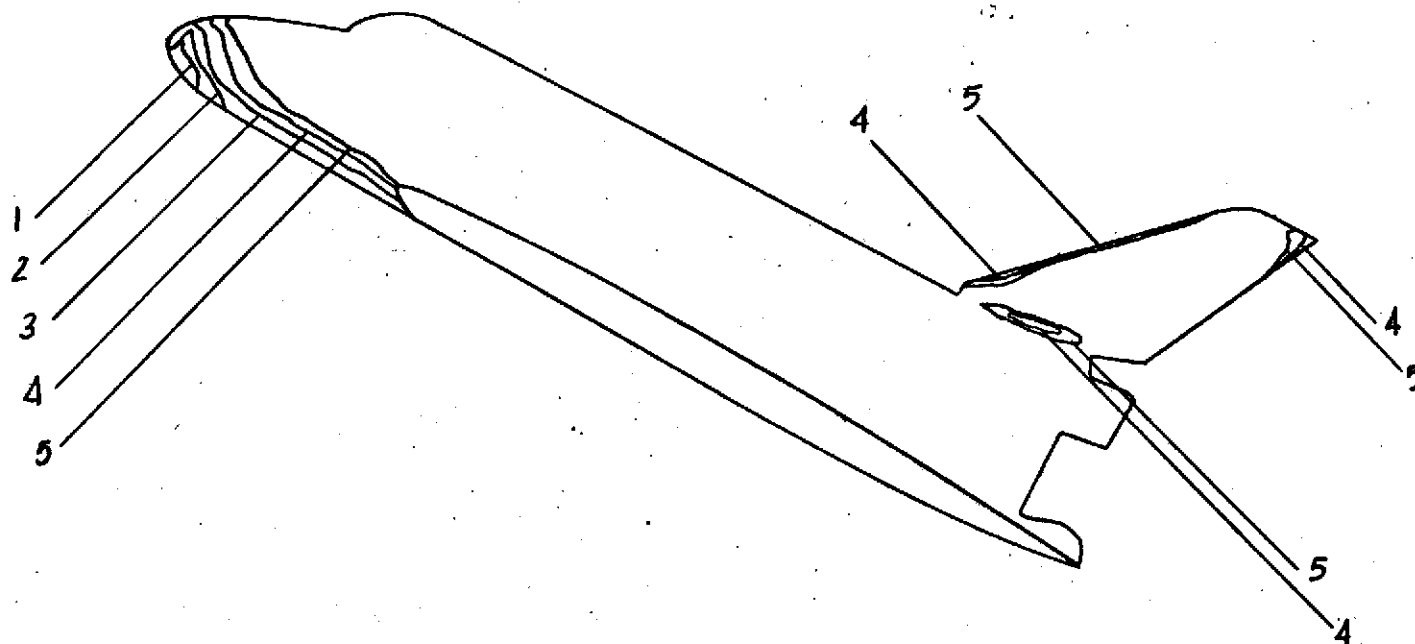
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.3019
2	.2062
3	.1350
4	.0922
5	.0714
6	
7	
8	
9	
10	

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FIGURE 77

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3807

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 774.7$

$T_{total} \text{ (°R)} = 1390$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \ change} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

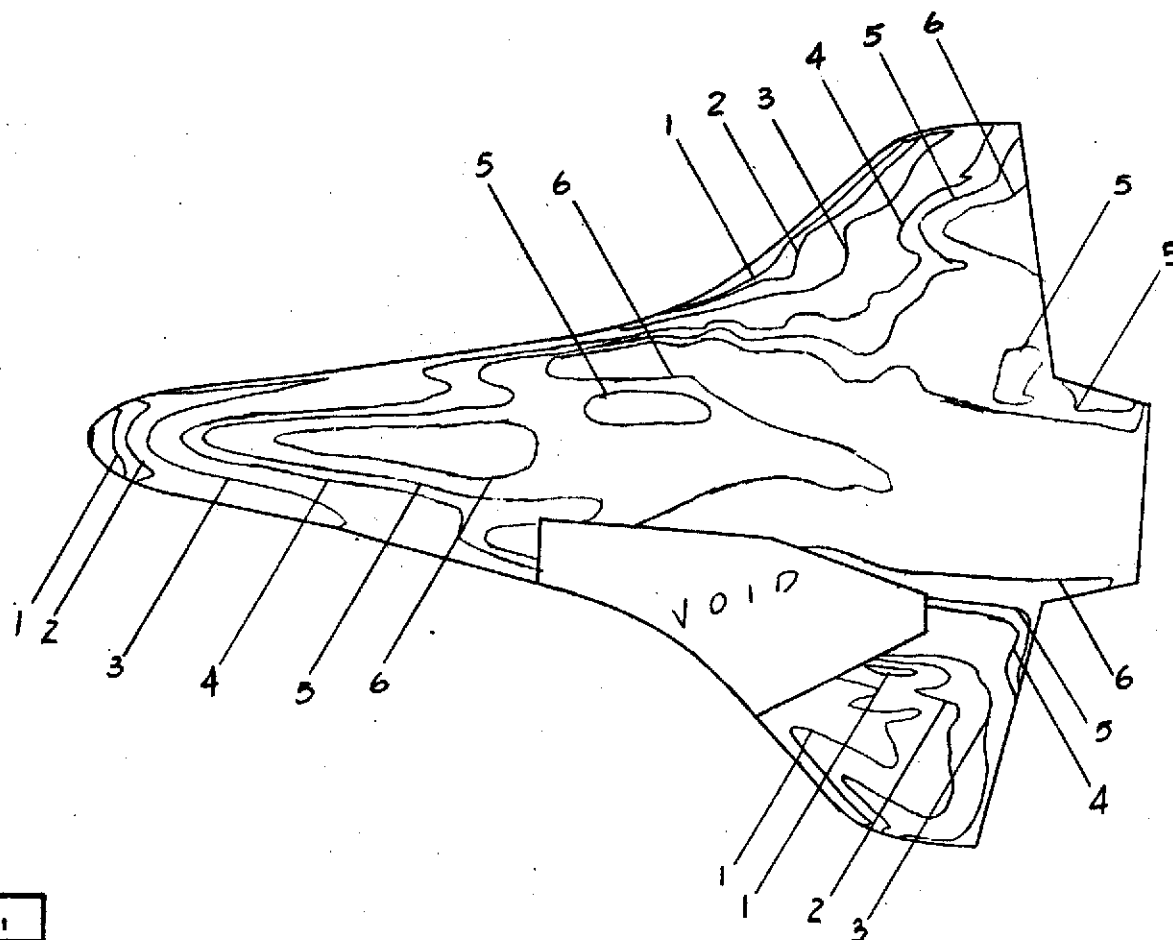
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.2707
2	.2060
3	.1518
4	.1114
5	.0992
6	.0832
7	
8	
9	
10	

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FIGURE 78

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3808

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1360$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

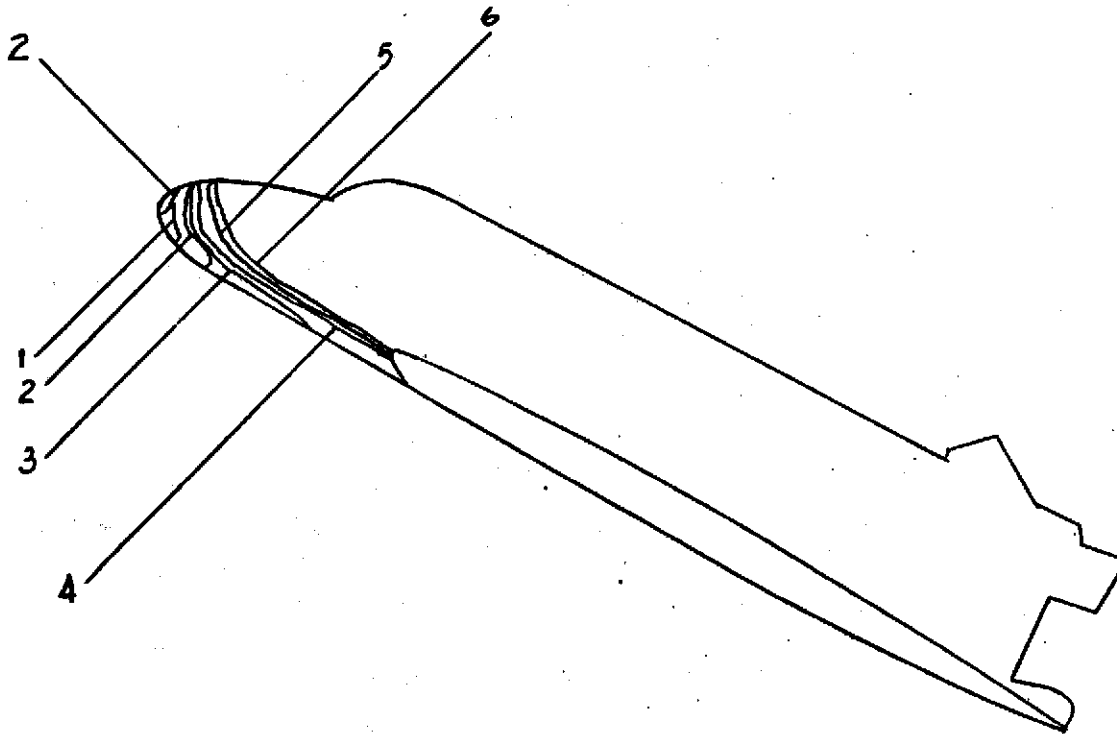
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{pm1}$
1	.3262
2	.2063
3	.1559
4	.1305
5	.0972
6	.0809
7	
8	
9	
10	

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FIGURE 79

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3808

$M_\infty = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}R$ ) = 1360

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 300

$\alpha = 30$

$\beta = 0$

$\phi = 180$

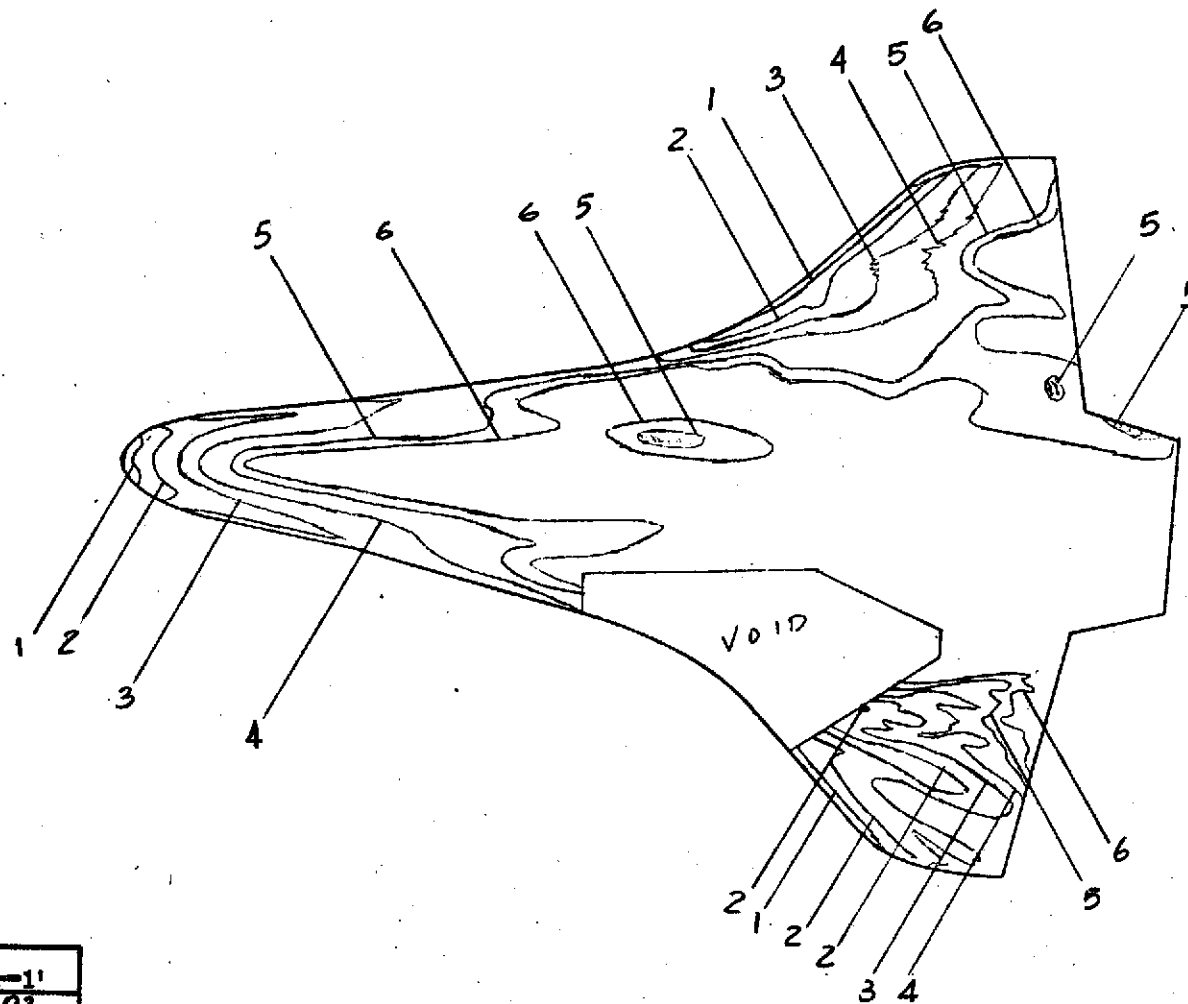
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{F=1}$
1	.3583
2	.2363
3	.1689
4	.1364
5	.1085
6	.0990
7	
8	
9	
10	

PAGE 106  
FIGURE 80

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3809

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1395$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

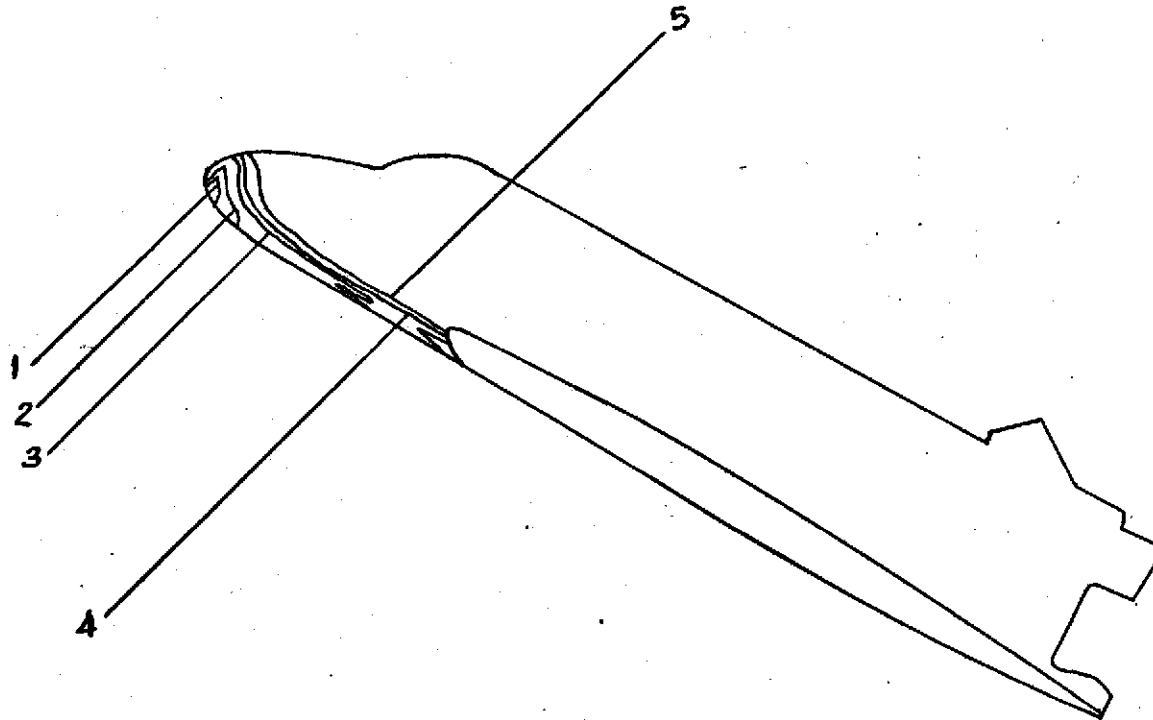
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.4406
2	.2607
3	.1689
4	.1393
5	.1043
6	
7	
8	
9	
10	

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FIGURE 81

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3809

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1395$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

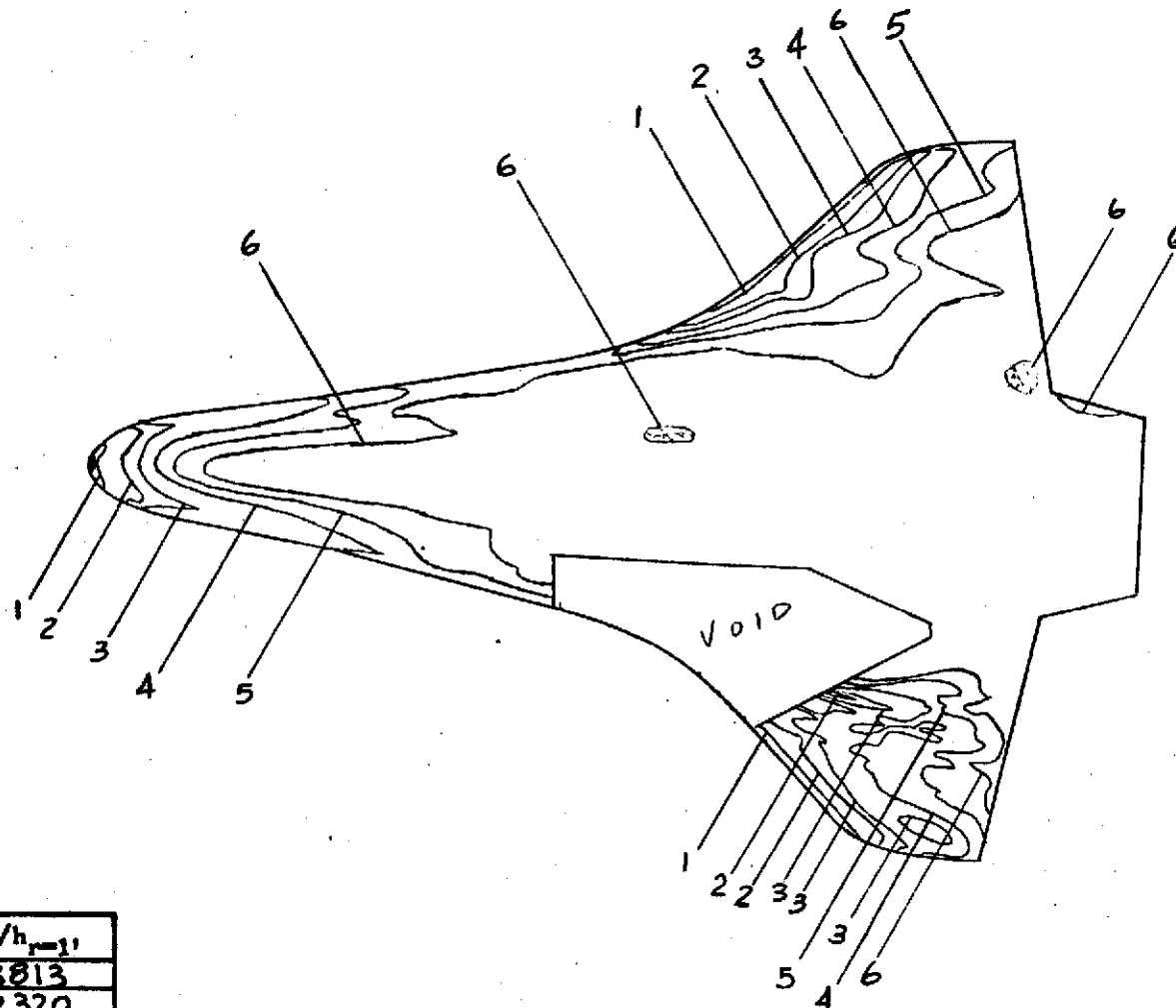
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{film}}$
1	.3813
2	.2320
3	.1883
4	.1462
5	.1264
6	.1058
7	
8	
9	
10	

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FIGURE 82

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3810

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 639.7$

$T_{\text{total}} \text{ (}^{\circ}\text{R)} = 1365$

$T_{\text{aw}}/T_{\text{total}} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

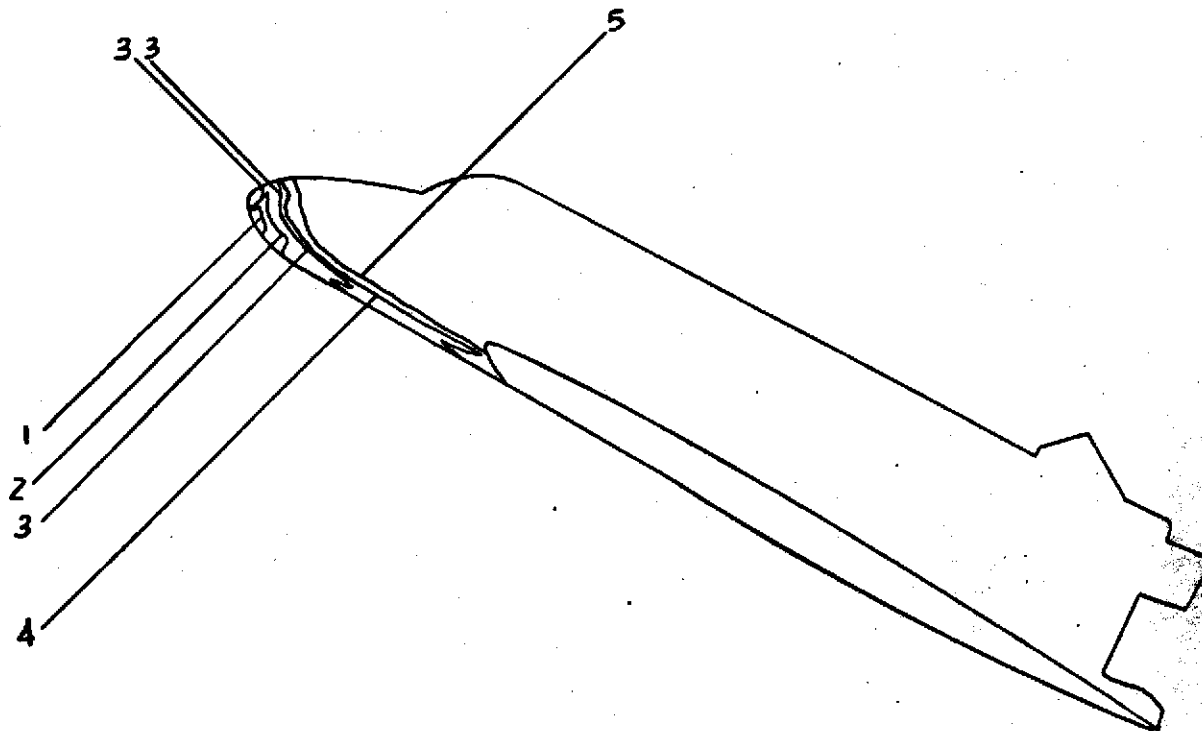
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.2585
2	.2535
3	.1756
4	.1484
5	.1134
6	
7	
8	
9	
10	

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FIGURE 83

CONFIG.

LENGTH (in) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3810

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1365$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

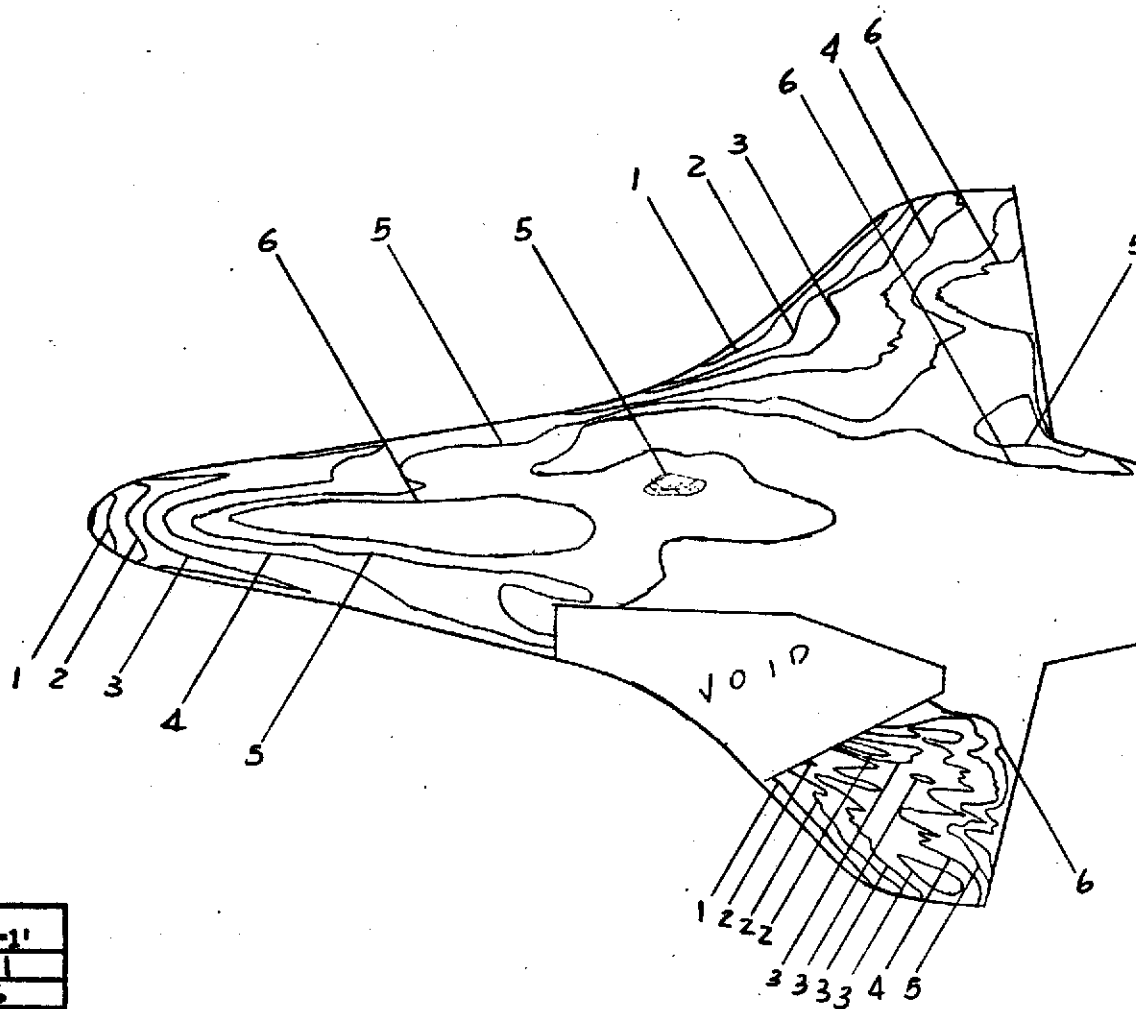
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.2921
2	.2016
3	.1608
4	.1234
5	.1014
6	.0901
7	
8	
9	
10	

PAGE 110  
FIGURE 84

CONFIG.

LENGTH (#) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3811

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1345$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

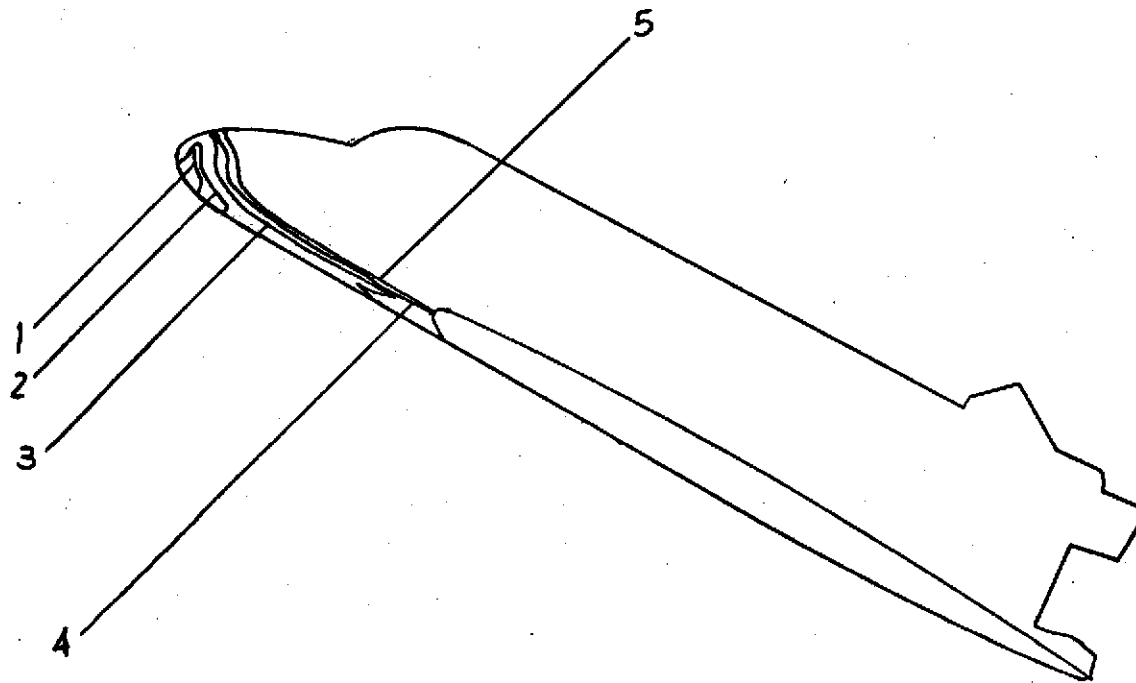
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.3002
2	.2123
3	.1501
4	.1135
5	.0949
6	
7	
8	
9	
10	

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FIGURE 85

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3811

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1345$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

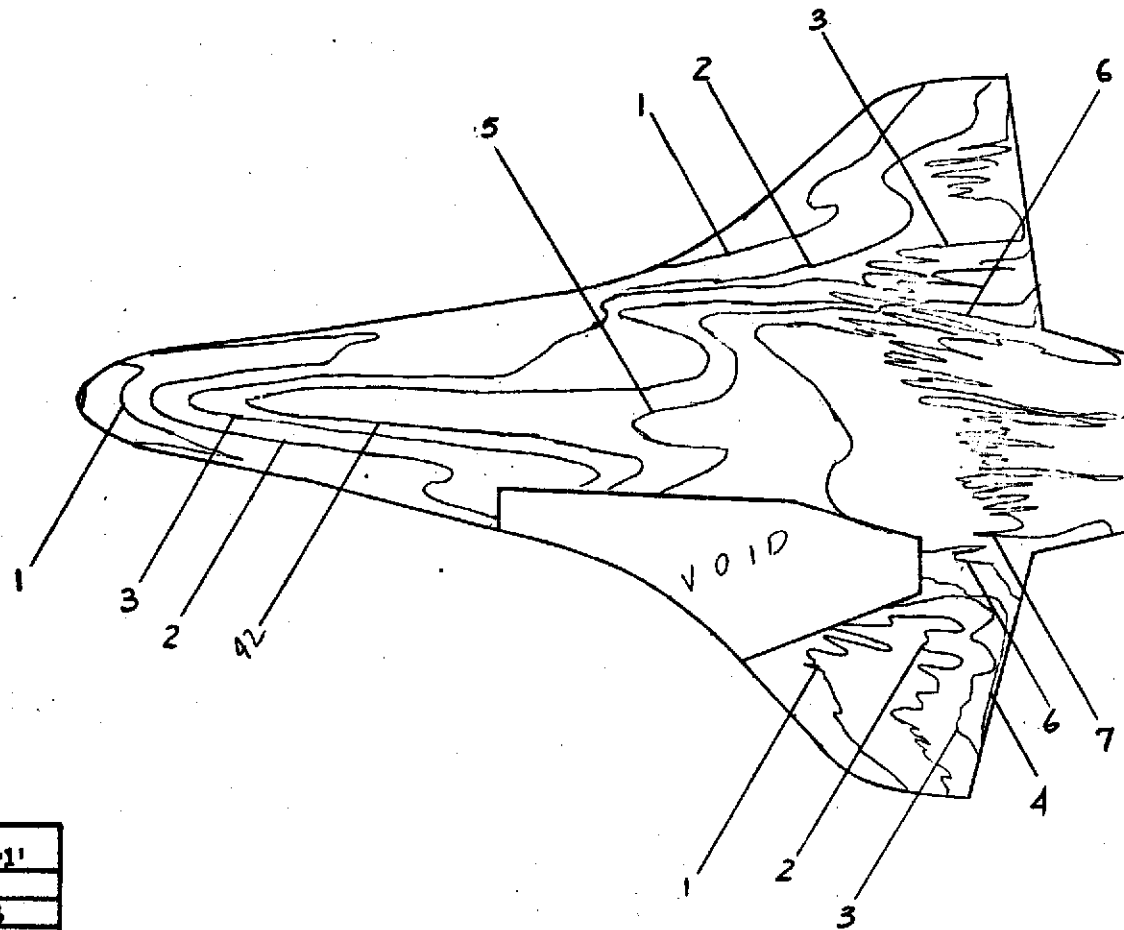
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{film}}$
1	.1558
2	.1098
3	.0805
4	.0758
5	.0675
6	.0533
7	.0412
8	
9	
10	

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FIGURE 86

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3812

$M_{\infty}$  = 7.9

$P_{\text{total}}$  (psia) = 174.7

$T_{\text{total}}$  ( $^{\circ}$ R) = 1275

$T_{\text{aw}}/T_{\text{total}}$  = .91

$R_N$  per foot =

$T_{\text{phase change}}$  ( $^{\circ}$ F) = 150

$\alpha$  = 30

$\beta$  = 0

$\phi$  = 180

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

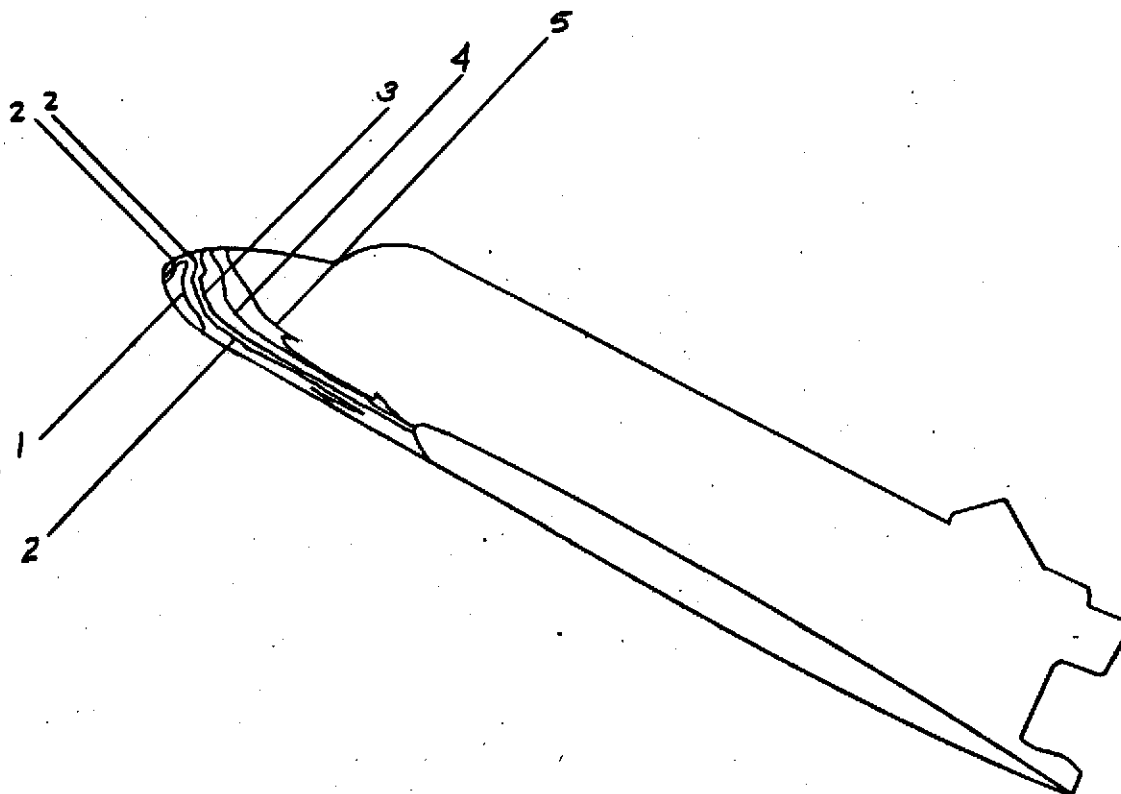
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.1899
2	.1343
3	.1003
4	.0649
5	.0441
6	
7	
8	
9	
10	

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FIGURE 87

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3812

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (°R)} = 1275$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

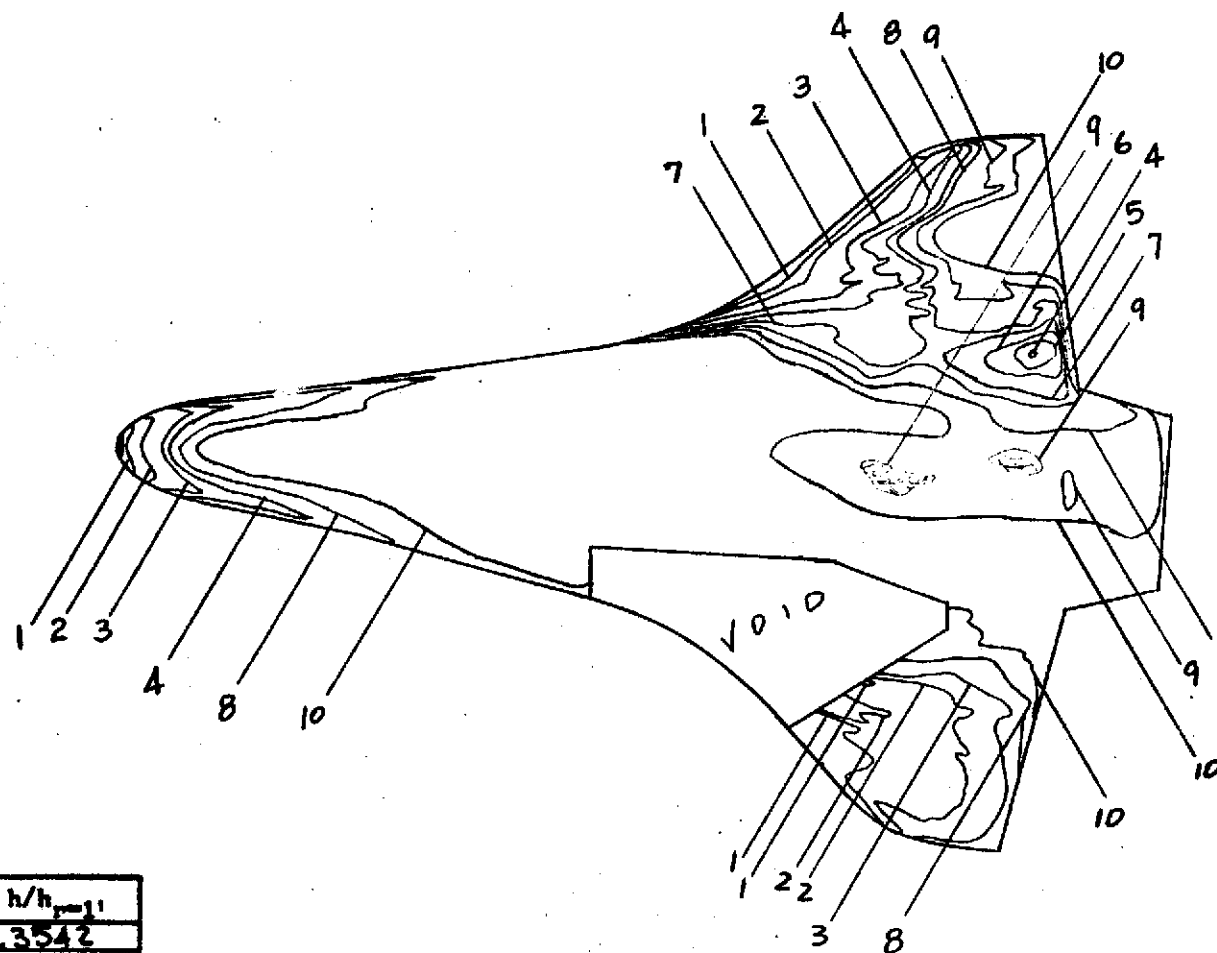
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3542
2	.2644
3	.1819
4	.1619
5	.1356
6	.1499
7	.1448
8	.1402
9	.1287
10	.1176

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FIGURE 88

CONFIG.

LENGTH (R) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3813

$M_\infty = 7.9$

$P_{total}$  (psia) = 1039.7

$T_{total}$  ( $^{\circ}$ R) = 1425

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

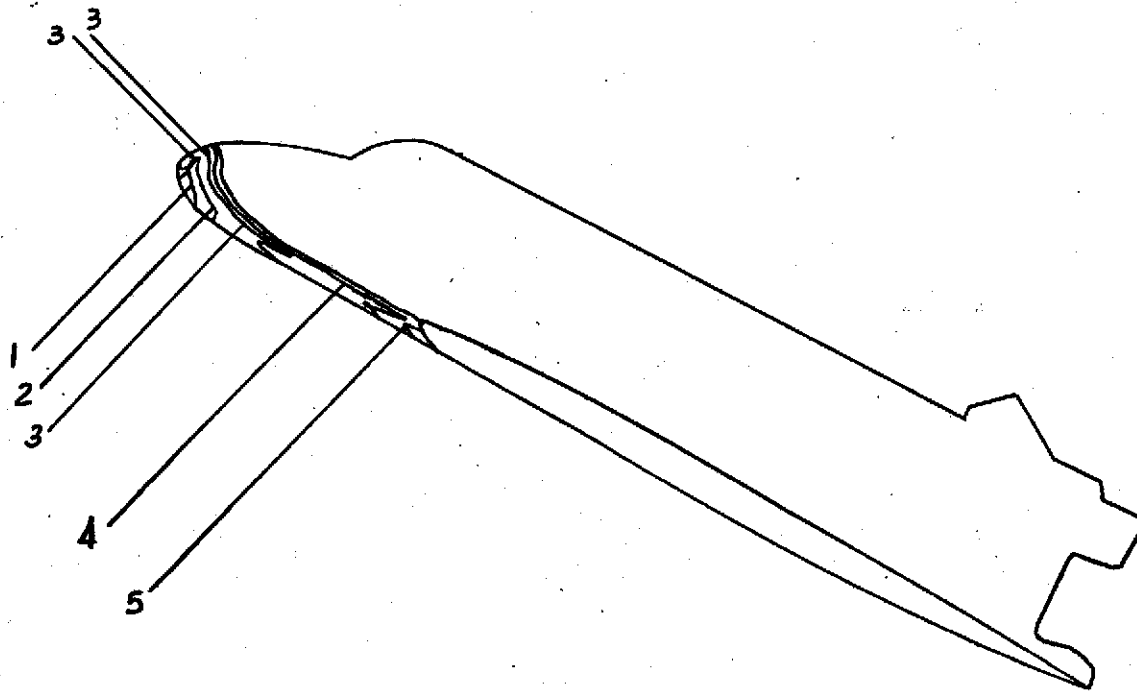
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3397
2	.2360
3	.1635
4	.1382
5	.1219
6	
7	
8	
9	
10	

PAGE 115  
FIGURE 89

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3813

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1039.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1425$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

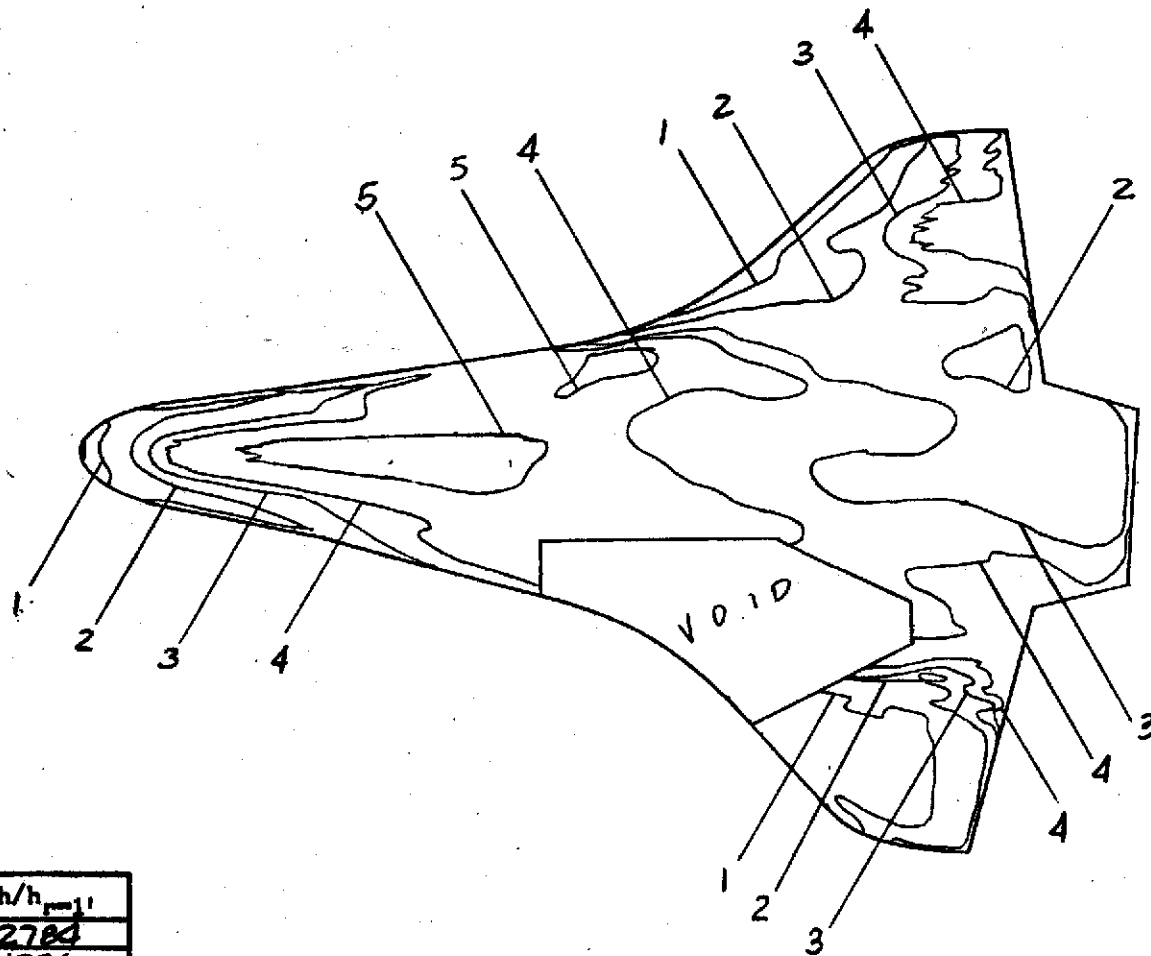
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{film}$
1	.2704
2	.1226
3	.1410
4	.1233
5	.0913
6	
7	
8	
9	
10	

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FIGURE 90

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3814

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1064.7$

$T_{total} \text{ (}^\circ\text{R)} = 1405$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

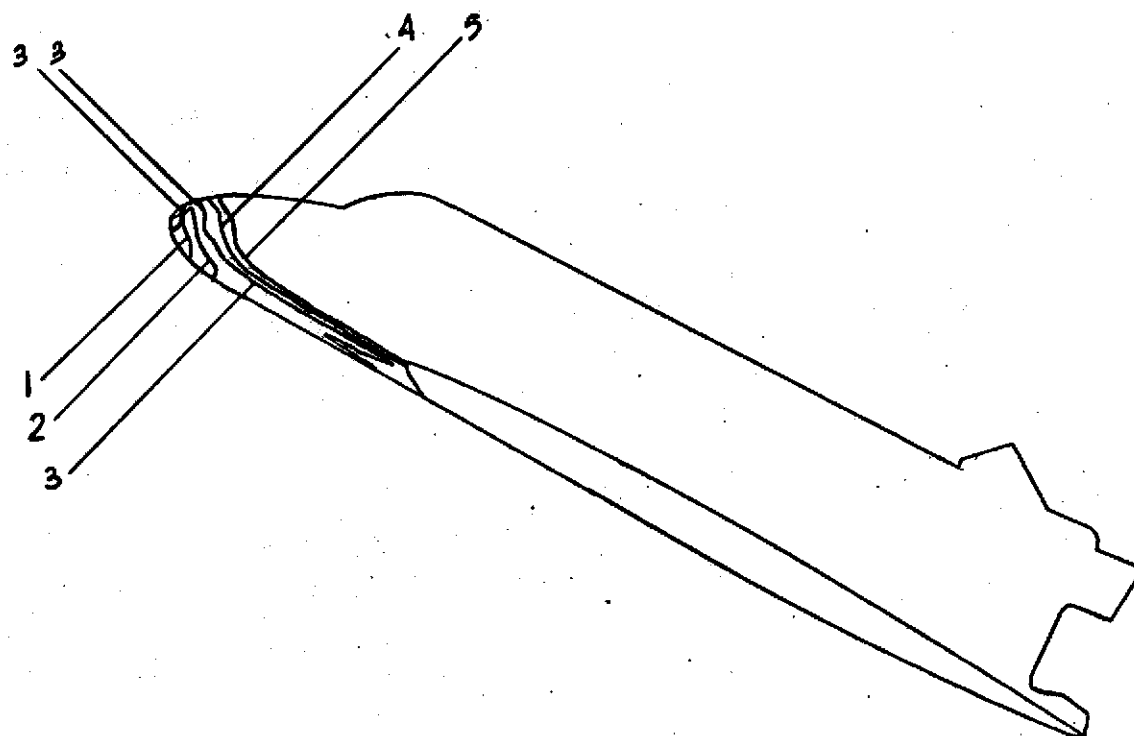
y (in) =

z (in) =

HVD-EVCB



# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.3422
2	.2338
3	.1653
4	.1169
5	.0954
6	
7	
8	
9	
10	

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FIGURE 91

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3814

$M_\infty = 7.9$

$P_{total}$  (psia) = 1064.7

$T_{total}$  ( $^{\circ}R$ ) = 1405

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 350

$\alpha = 30$

$\beta = 0$

$\phi = 180$

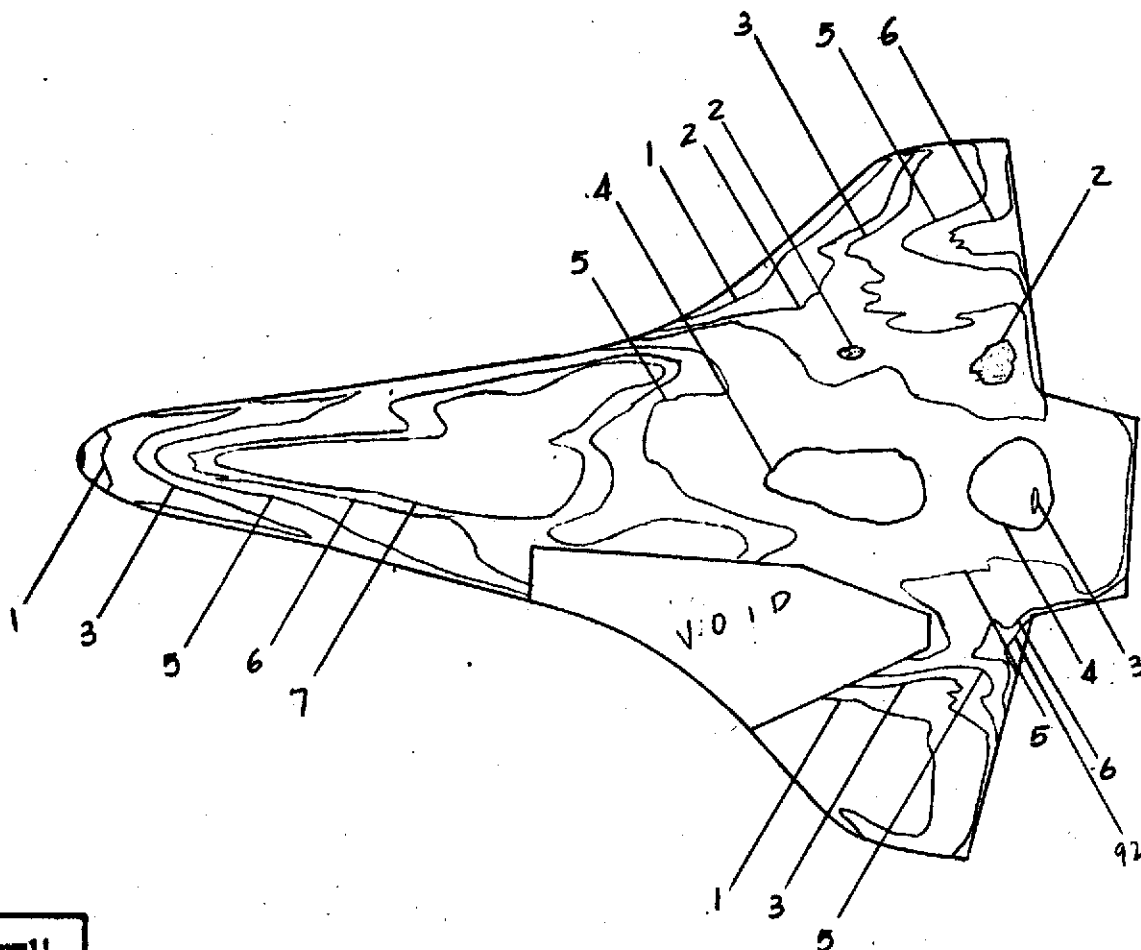
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

## PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	2728
2	1853
3	1645
4	1476
5	1323
6	1091
7	0983
8	
9	
10	

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**FIGURE 92**

**CONFIG.**

LENGTH (ft) -

SCALE .006

FACILITY LRC-VDT

**TEST**

RUN 3815

$M_{\bullet} = 7.9$

$$P_{\text{total}} \text{ (psia)} = 1064.7$$
$$T_{\text{total}} (^{\circ}\text{R}) = 1370$$
$$T_{aw}/T_{total} = .91$$

$R_N$  per foot =

$$T_{\text{phase change}} (^{\circ}\text{F}) = 350$$
 $\alpha = 30$ 
$$\beta = 0$$
 $\phi = 180$ 

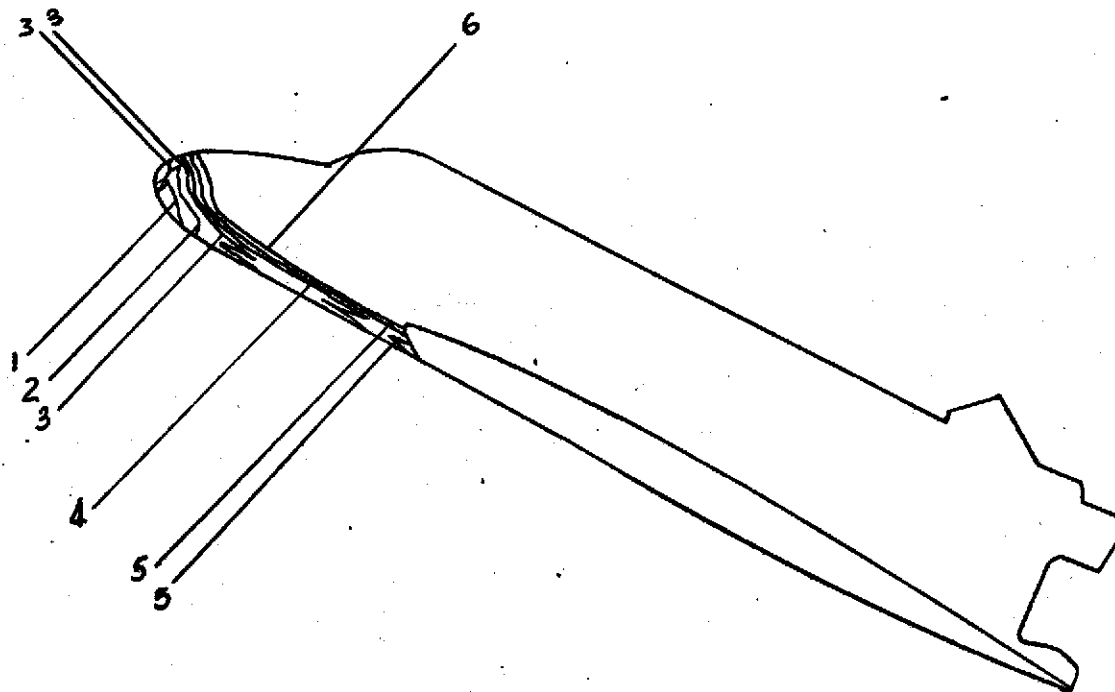
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

$$x(i n) =$$

**y (in) =**

**z (in) =**

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3077
2	.2176
3	.1777
4	.1539
5	.1256
6	.1026
7	
8	
9	
10	

PAGE 119  
FIGURE 93

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3815

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1064.7$

$T_{total} \text{ (}^\circ\text{R)} = 1370$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

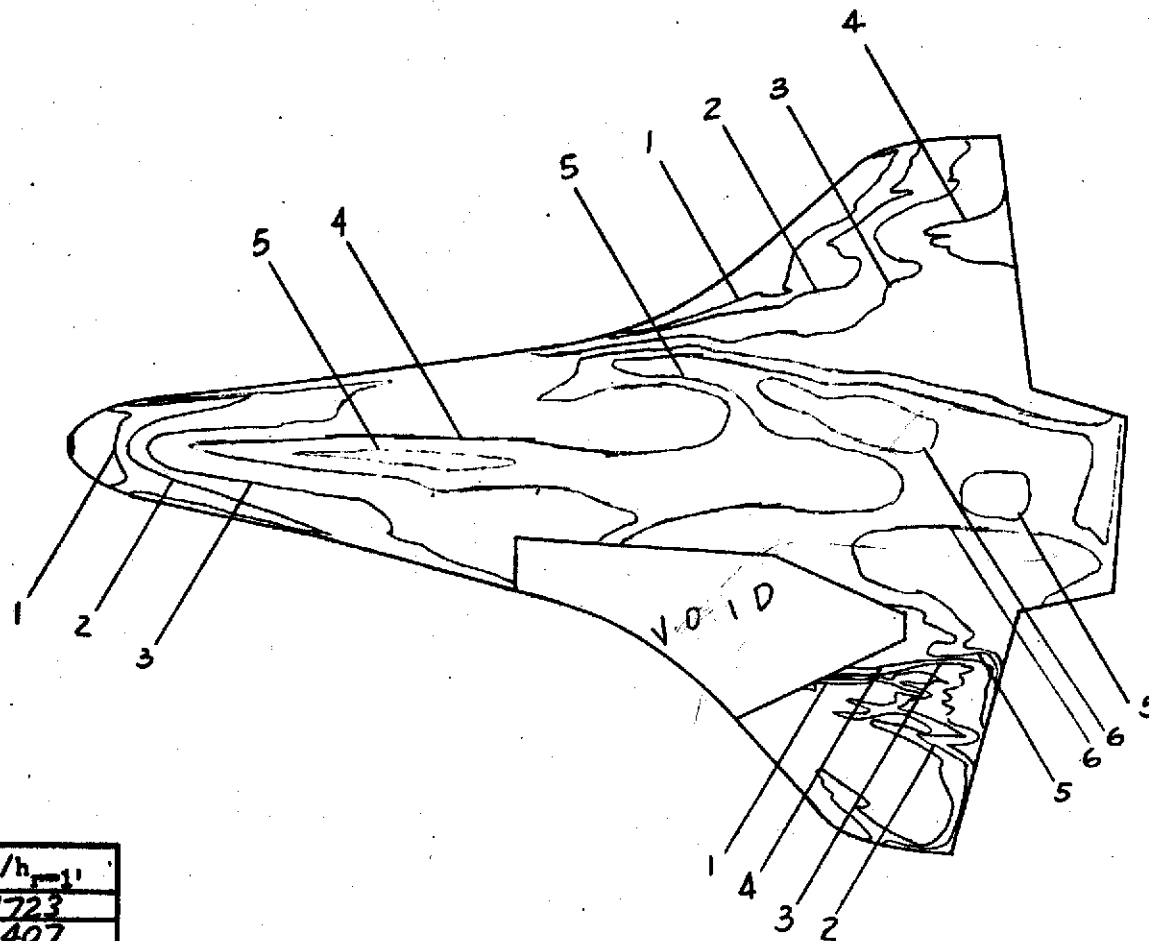
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1723
2	.1407
3	.1128
4	.0880
5	.0798
6	.0694
7	
8	
9	
10	

PAGE 120  
FIGURE 94

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC -VDT

TEST

RUN 3816

$M_\infty = 7.9$

$P_{total}$  (psia) = 664.7

$T_{total}$  ( $^{\circ}R$ ) = 1385

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 250

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

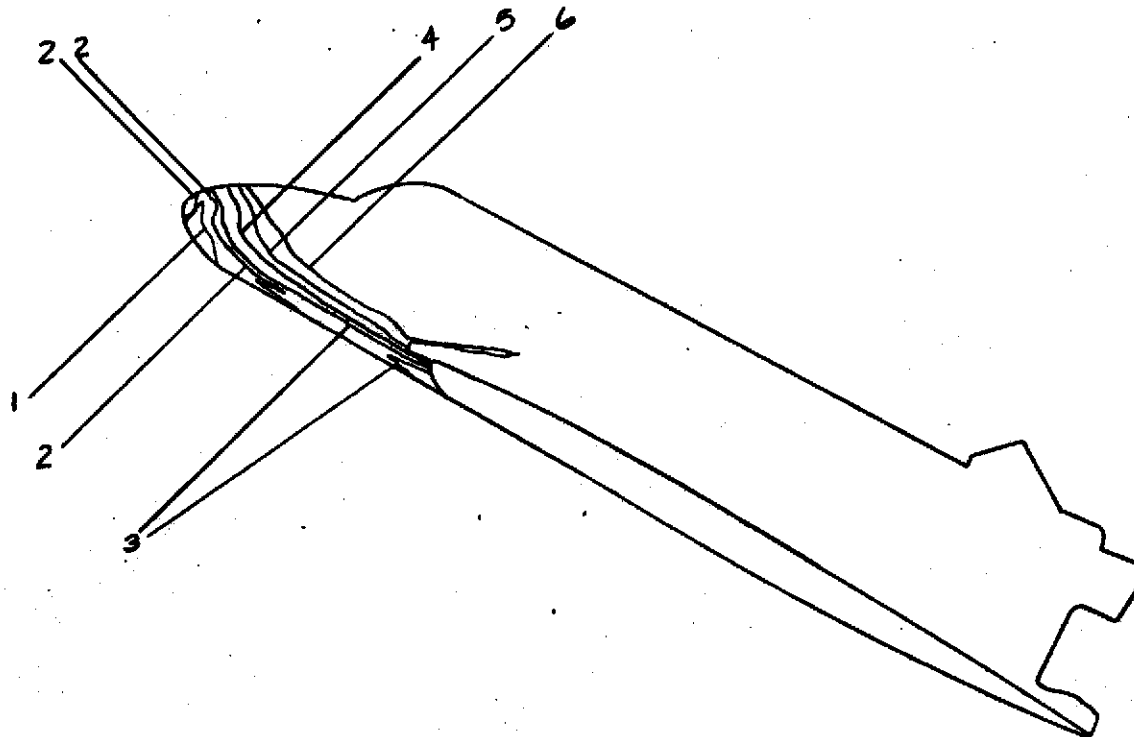
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{m=1}$
1	.2312
2	.1579
3	.1368
4	.0944
5	.0731
6	.0583
7	
8	
9	
10	

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FIGURE 95

CONFIG.

LENGTH (ft) =

SCALE 006

FACILITY LRC-VDT

TEST

RUN 3816

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (}^\circ\text{R)} = 1385$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 250$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

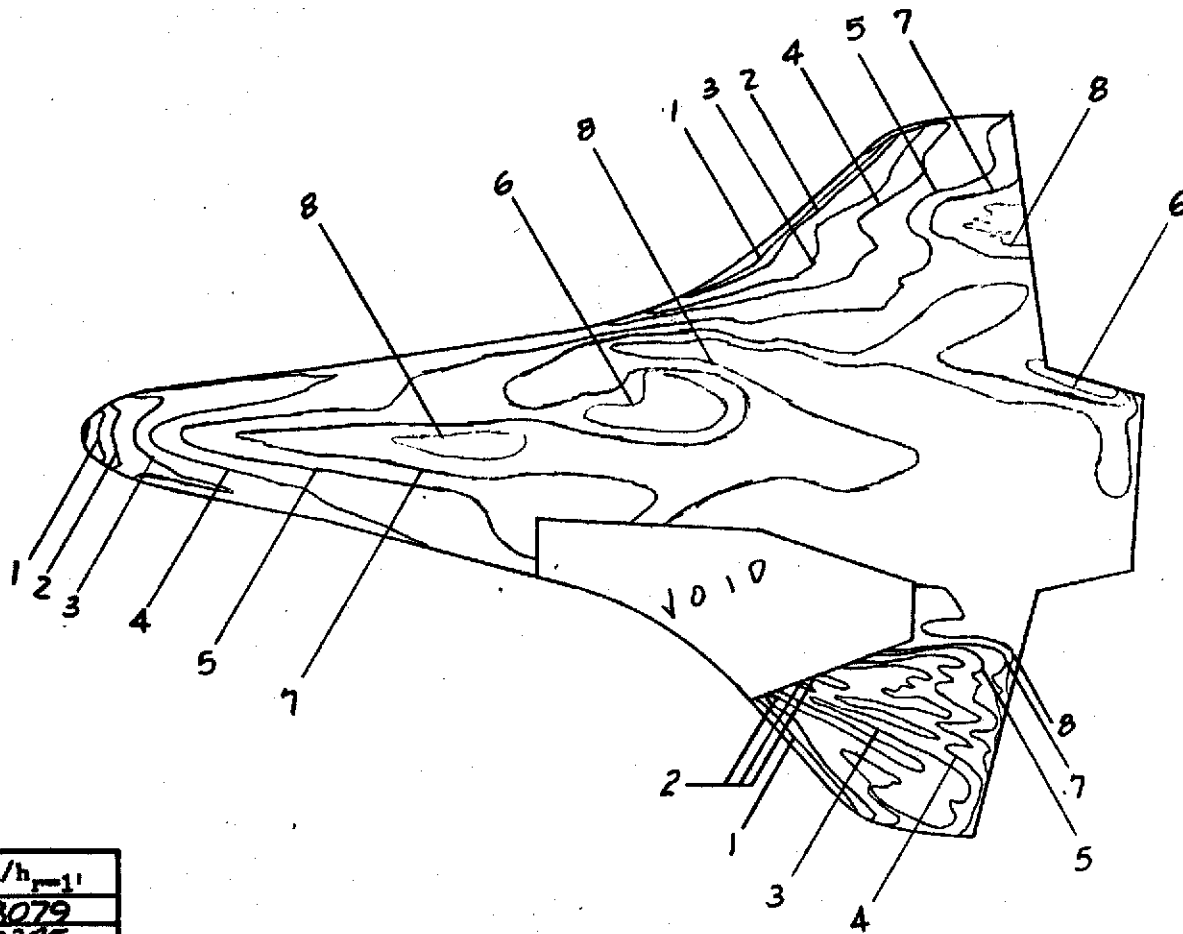
x (in) =

y (in) =

z (in) =

EVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.3079
2	.2385
3	.1716
4	.1392
5	.1104
6	.1014
7	.0938
8	.0854
9	
10	

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FIGURE 96

## CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3817

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1345$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

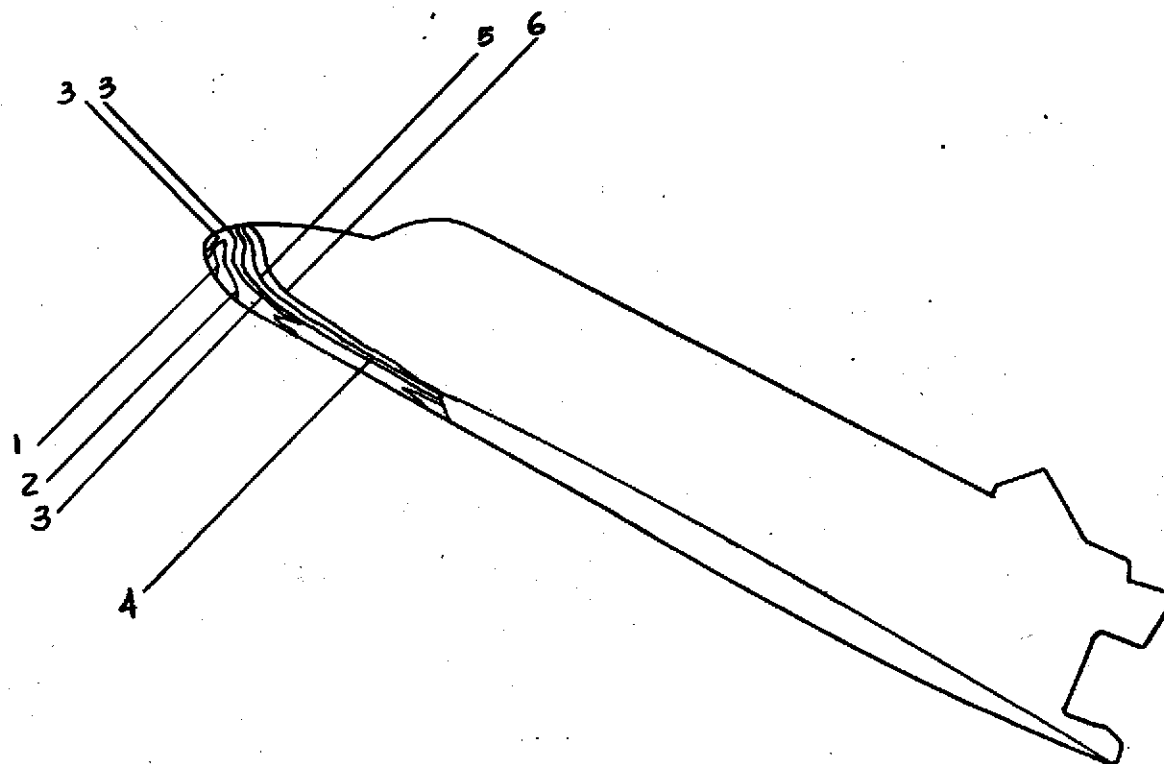
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{film}}$
1	.3588
2	.2451
3	.1733
4	.1415
5	.1135
6	.0905
7	
8	
9	
10	

PAGE 123  
FIGURE 97

CONFIG.

LENGTH (ft) =

SCALE 006 =

FACILITY LRC - VDT

TEST

RUN 3817

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 639.7$

$T_{\text{total}} \text{ (°R)} = 1345$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

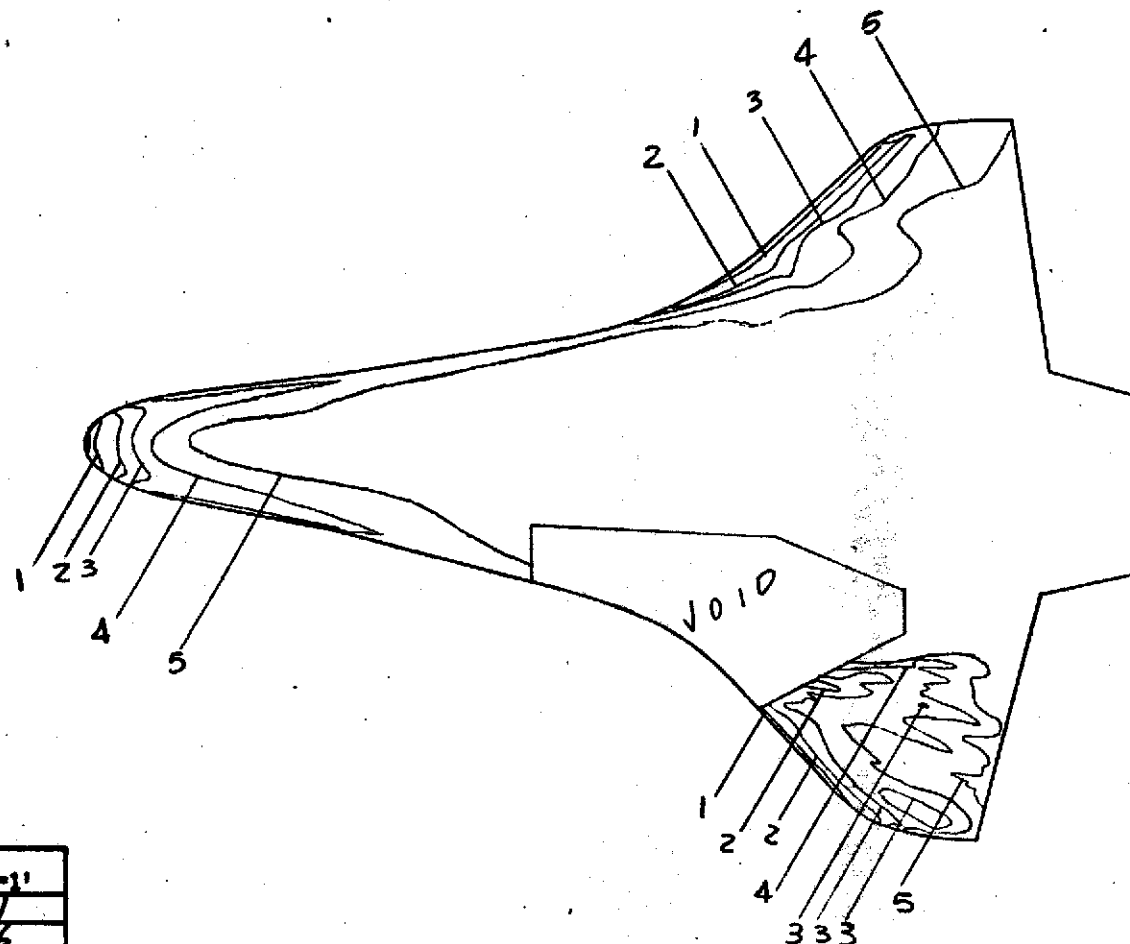
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.3971
2	.2746
3	.2137
4	.1646
5	.1202
6	
7	
8	
9	
10	

PAGE 124  
FIGURE 98

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3818

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^\circ\text{R)} = 1320$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

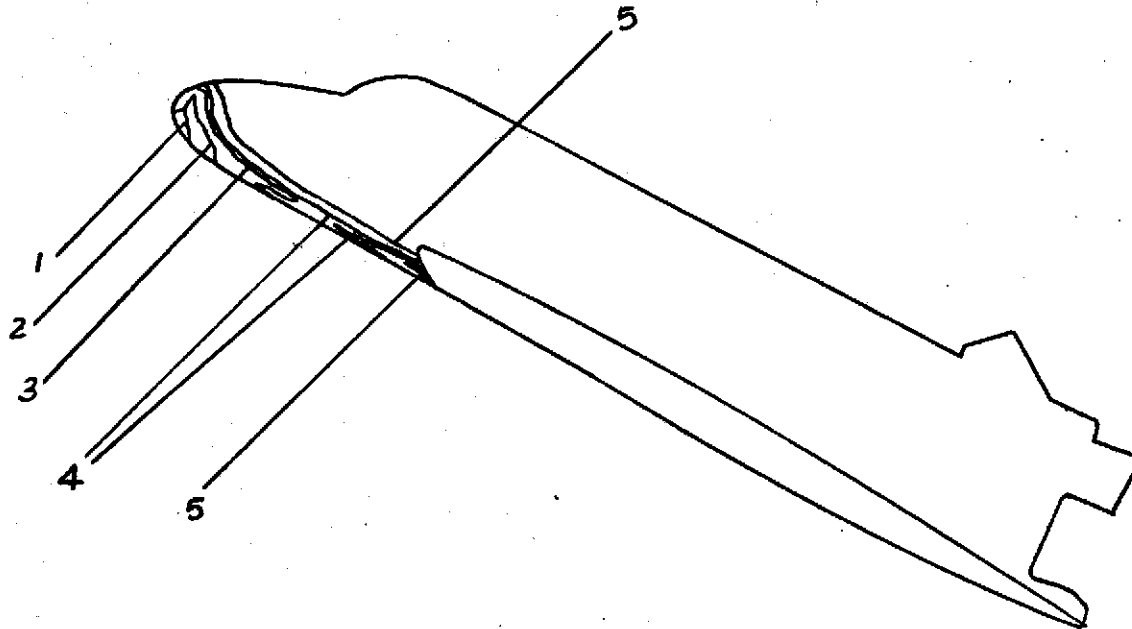
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	3924
2	2482
3	1755
4	1520
5	1268
6	
7	
8	
9	
10	

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FIGURE 99

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3818

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1320$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

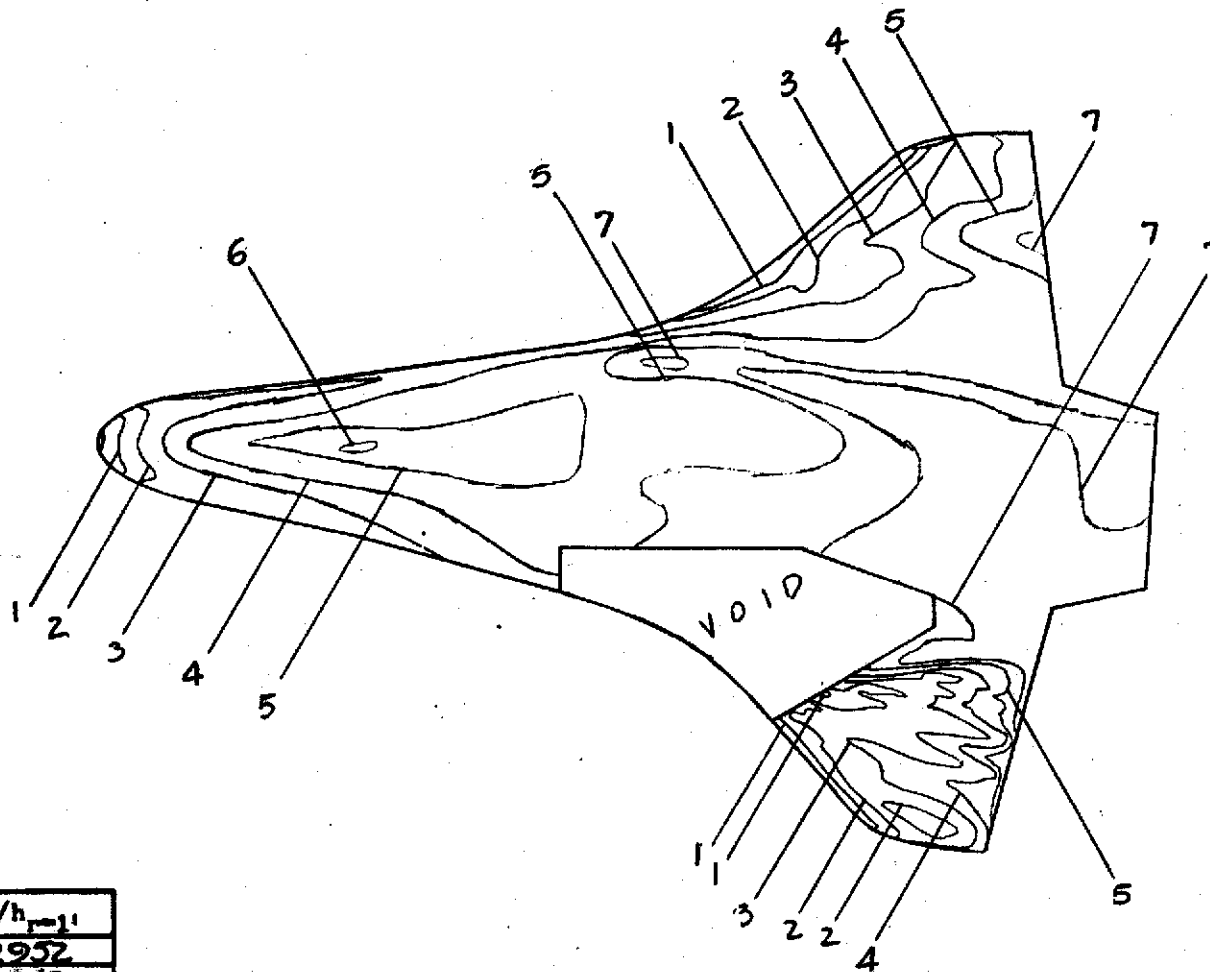
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.2952
2	.2142
3	.1556
4	.1248
5	.1019
6	.0938
7	.0867
8	
9	
10	

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FIGURE 100

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3819

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 649.7

$T_{total}$  (°R) = 1340

$T_{aw}/T_{total}$  = .91

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 300

$\alpha$  = 30

$\beta$  = 0

$\phi$  = 180

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

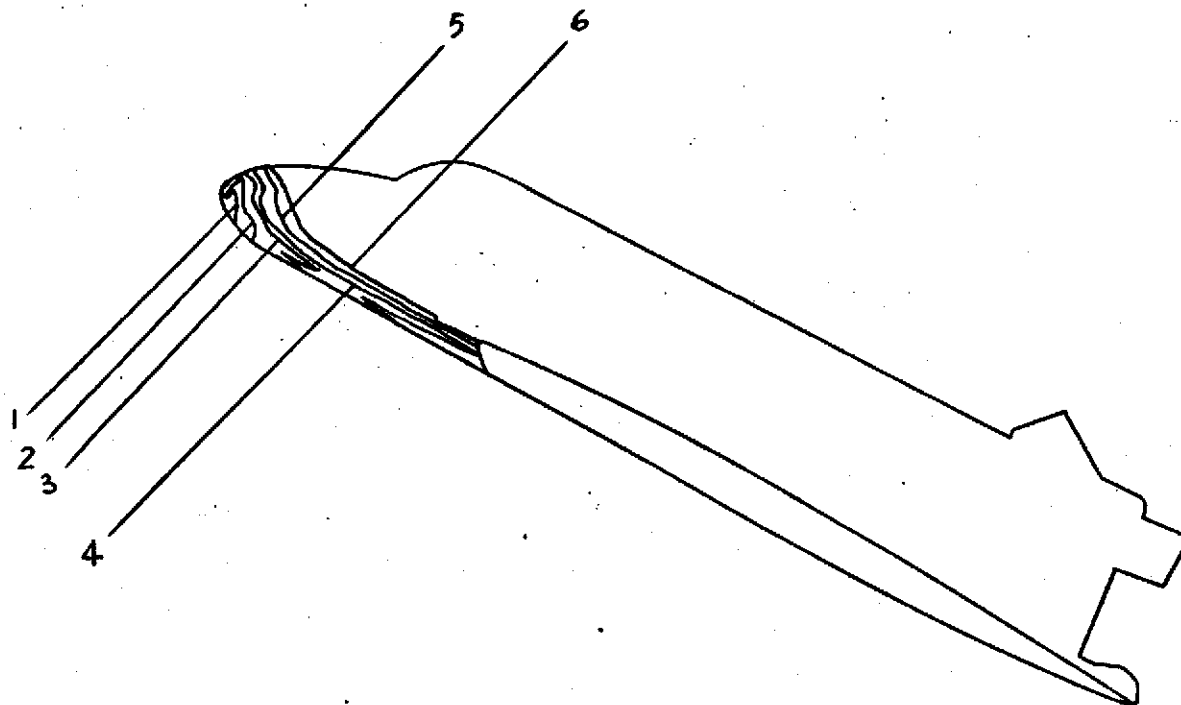
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{T=1}$
1	.3615
2	.2470
3	.1746
4	.1512
5	.1104
6	.0912
7	
8	
9	
10	

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FIGURE 101

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3819

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 649.7

$T_{total}$  (°R) = 1340

$T_{aw}/T_{total}$  = .90

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 300

$\alpha$  = 30

$\beta$  = 0

$\phi$  = 180

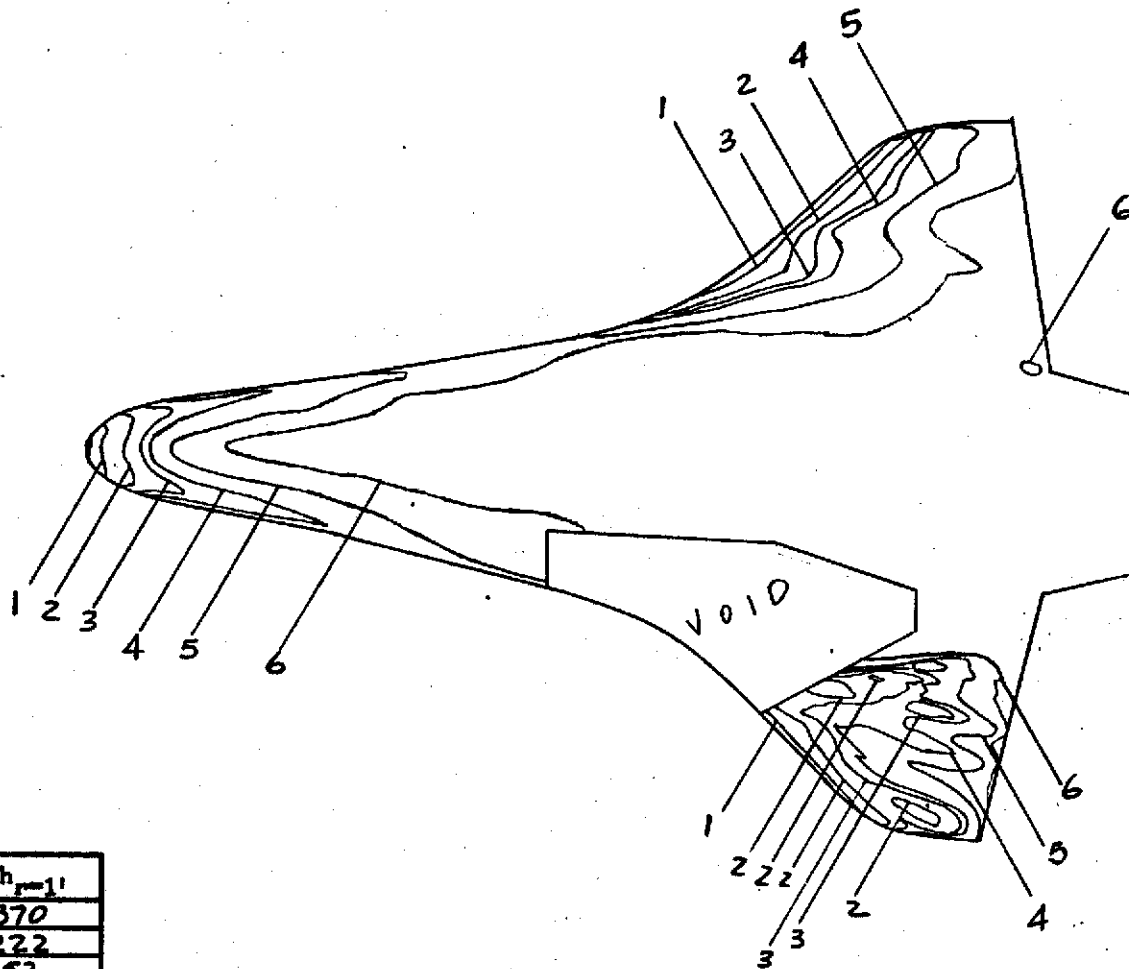
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.3370
2	.2222
3	.1752
4	.1355
5	.1231
6	.0973
7	
8	
9	
10	

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FIGURE 102

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3820

$M_o = 7.9$

$P_{total}$  (psia) = 664.7

$T_{total}$  ( $^{\circ}R$ ) = 1335

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 325

$\alpha = 30$

$\beta = 0$

$\phi = 180$

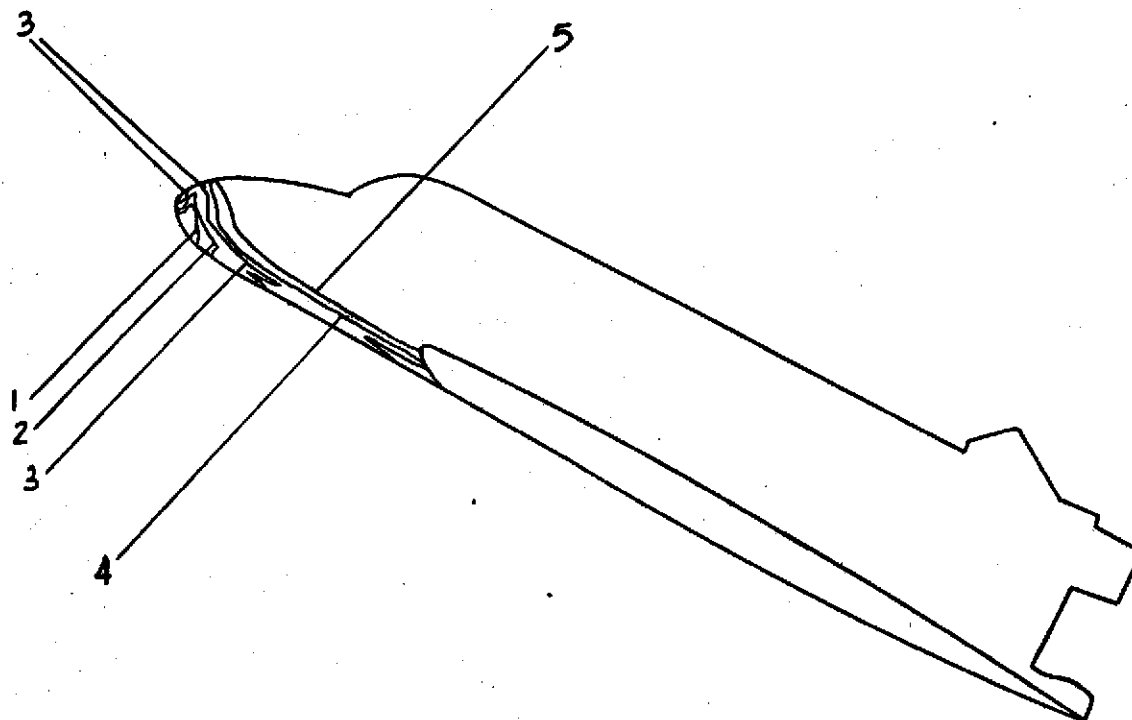
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{\text{ref}}$
1	.3470
2	.2454
3	.1735
4	.1267
5	.1023
6	
7	
8	
9	
10	

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FIGURE 103

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3820

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 664.7$

$T_{\text{total}} \text{ (}^{\circ}\text{R)} = 1335$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 325$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

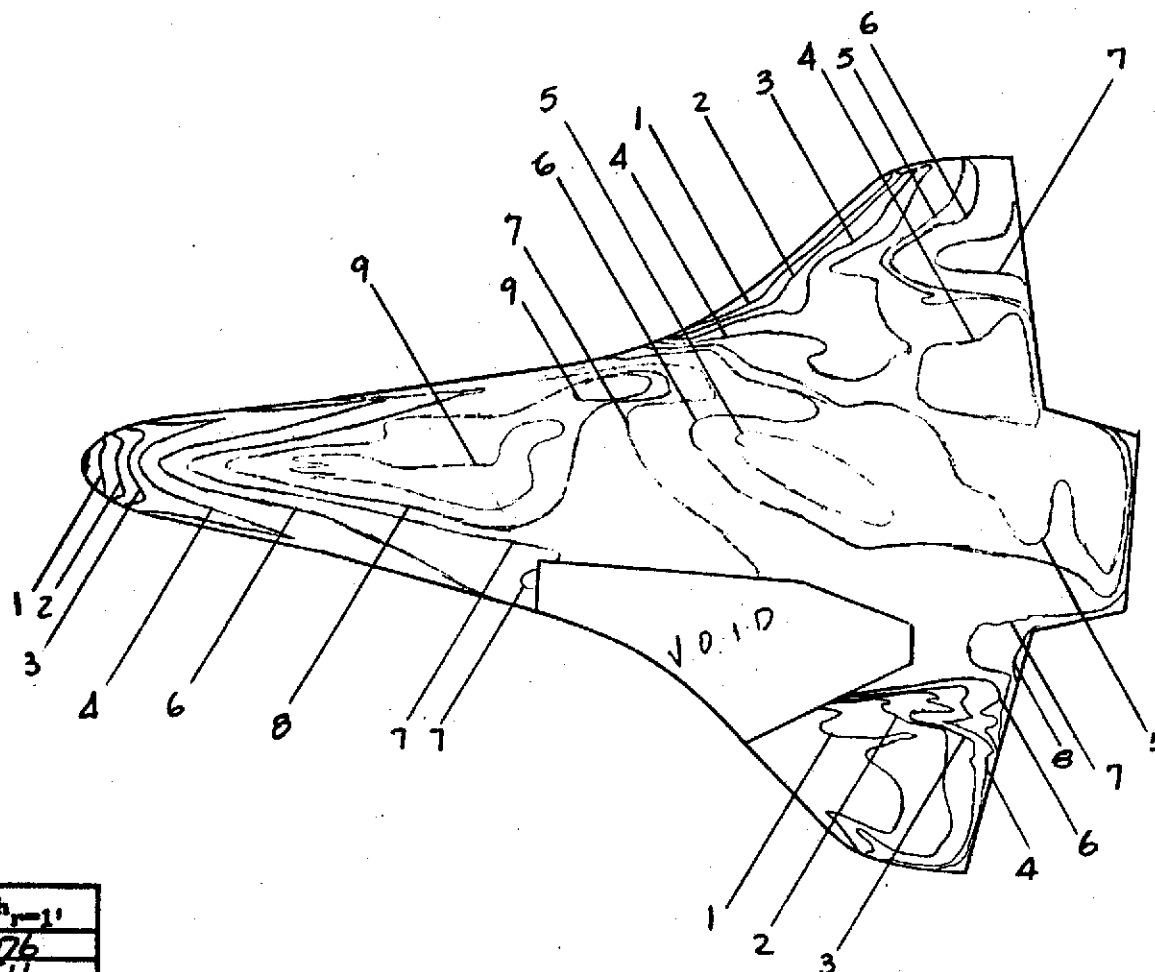
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.3076
2	.2511
3	.2051
4	.1706
5	.1471
6	.1393
7	.1133
8	.0985
9	.0893
10	

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FIGURE 104

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3821

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 1099.7

$T_{total}$  (°R) = 1405

$T_{aw}/T_{total}$  = .91

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 350

$\alpha$  = 30

$\beta$  = 0

$\phi$  = 180

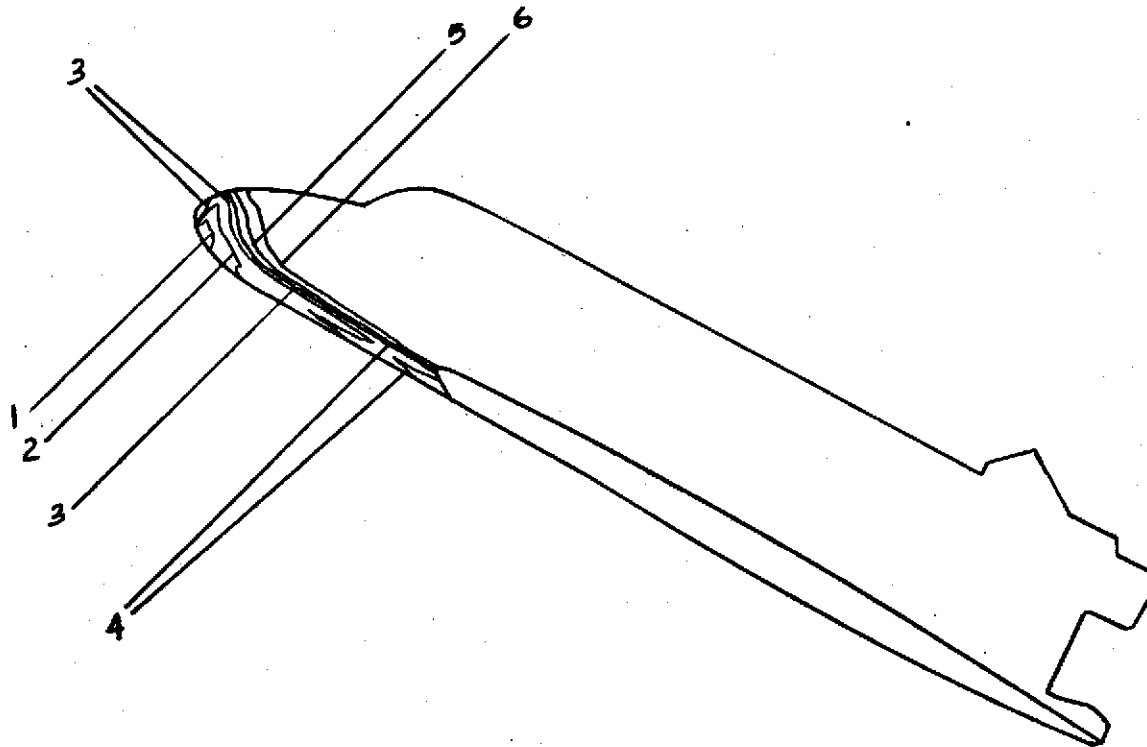
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3382
2	.2310
3	.1634
4	.1415
5	.1070
6	.0895
7	
8	
9	
10	

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FIGURE 105

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3821

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1099.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1405$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

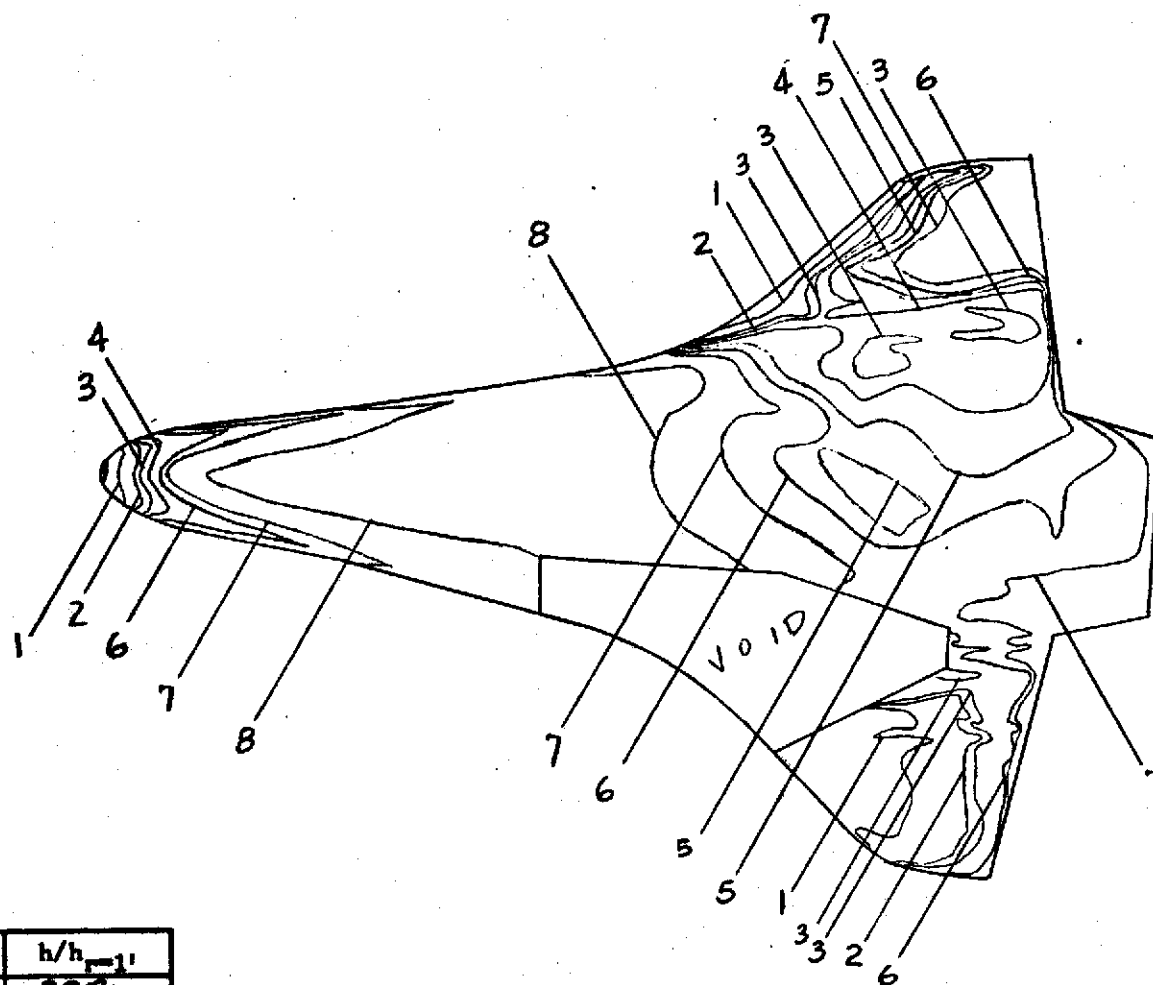
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.3380
2	.2519
3	.2229
4	.2020
5	.1782
6	.1690
7	.1512
8	.1173
9	
10	

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FIGURE 106

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC - VDT

TEST

RUN 3822

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1414.7$

$T_{total} \text{ (}^\circ\text{R)} = 1375$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

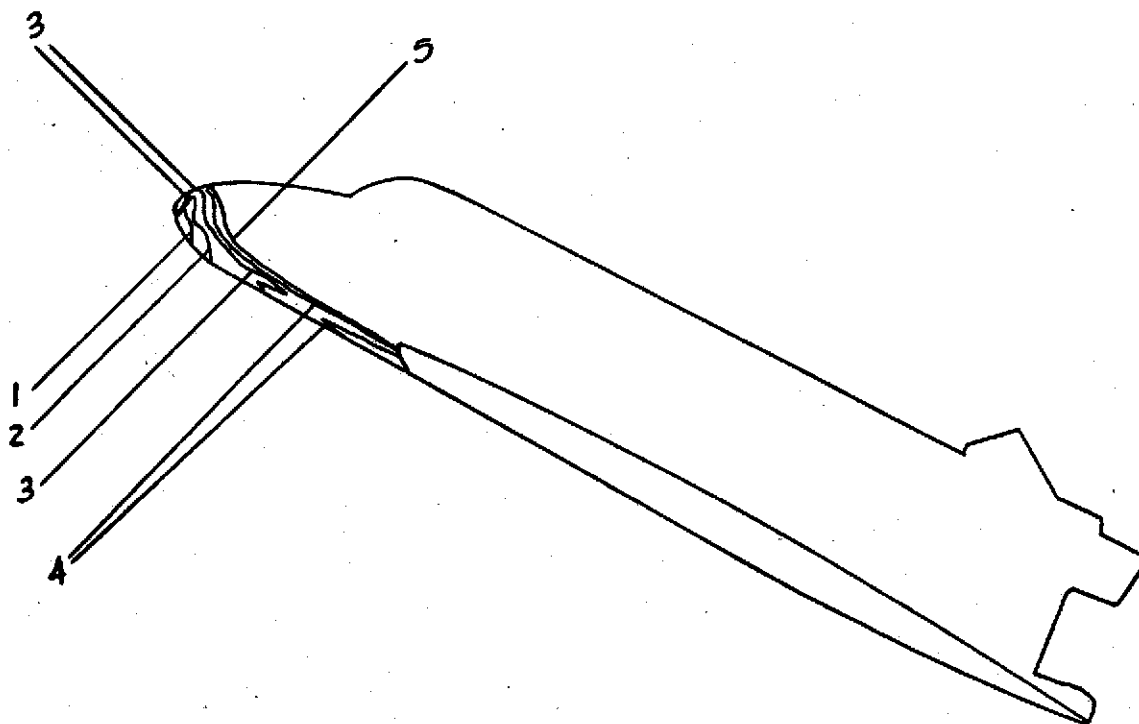
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3492
2	.2469
3	.1746
4	.1426
5	.1198
6	
7	
8	
9	
10	

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FIGURE 107

## CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3822

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1414.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1375$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

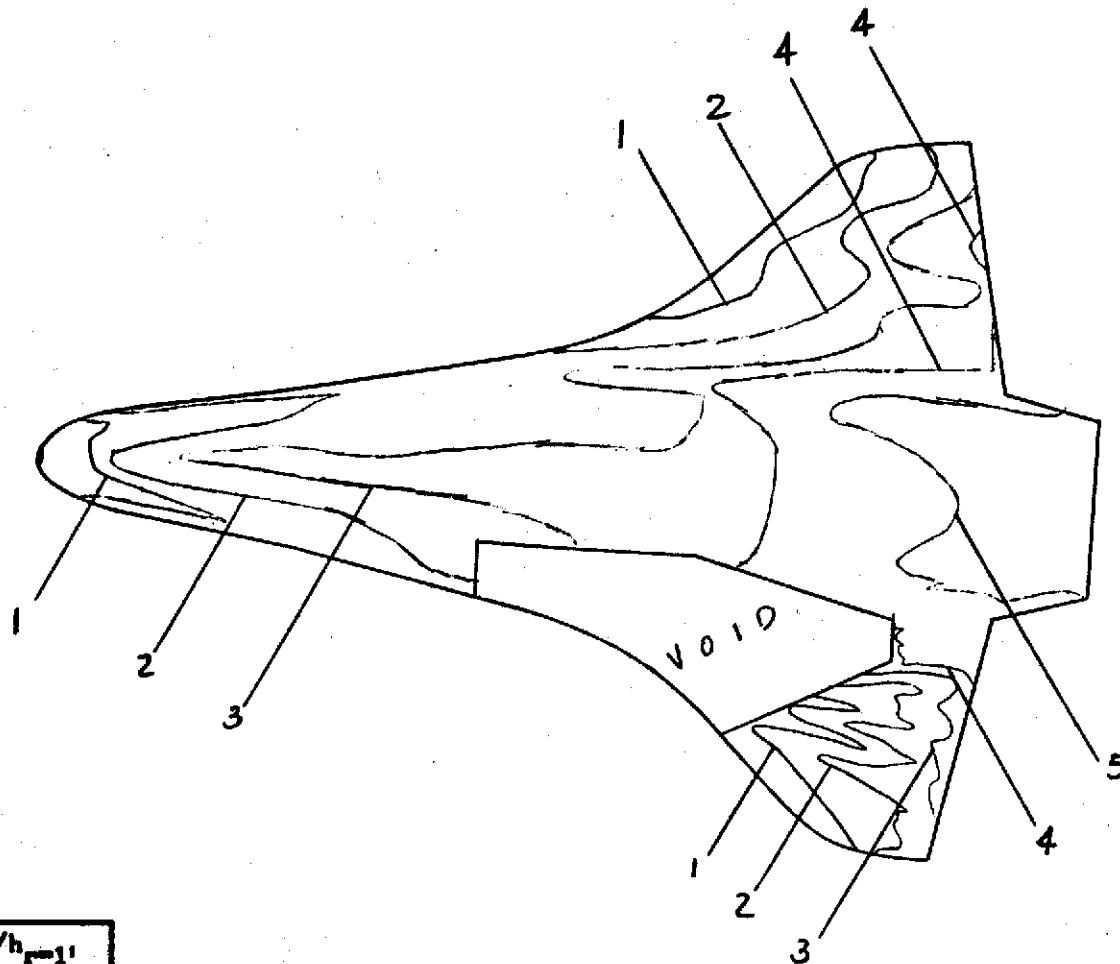
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.1369
2	.1109
3	.0805
4	.0651
5	.0406
6	
7	
8	
9	
10	

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FIGURE 108

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3823

$M_\infty = 7.9$

$P_{total}$  (psia) = 179.7

$T_{total}$  ( $^{\circ}R$ ) = 1225

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 150

$\alpha = 30$

$\beta = 0$

$\phi = 180$

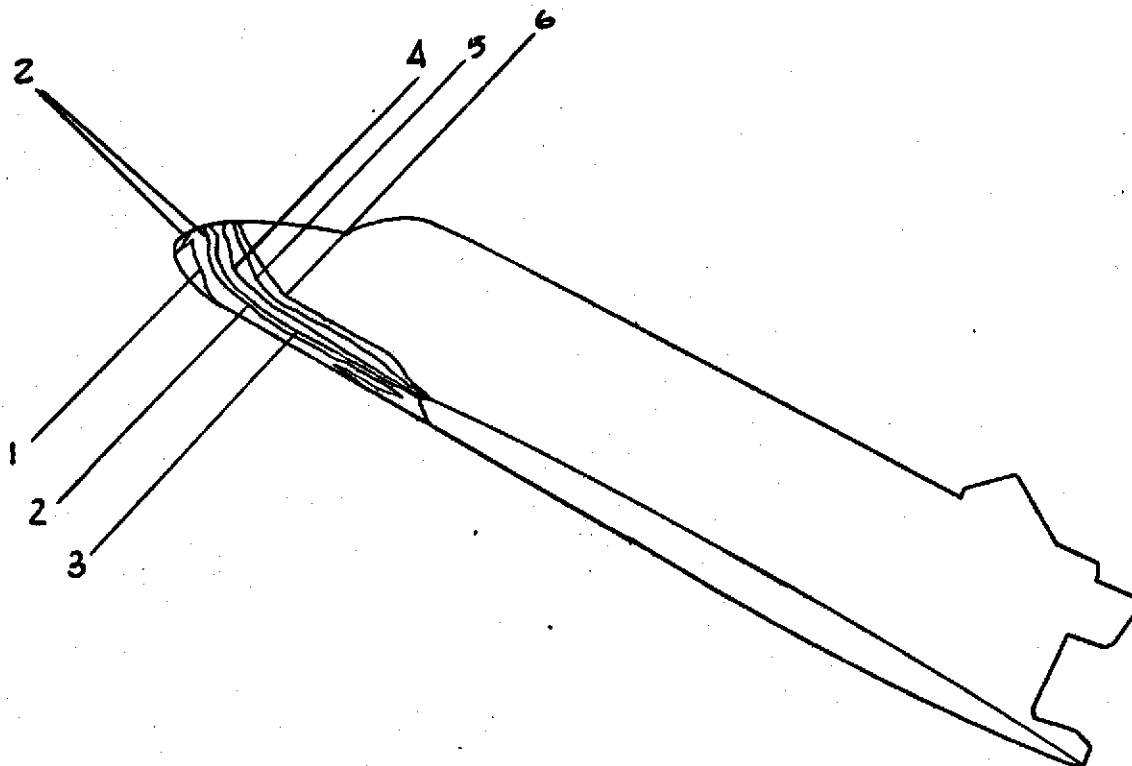
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.1920
2	.1312
3	.0928
4	.0719
5	.0508
6	.0422
7	
8	
9	
10	

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FIGURE 109

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3823

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 179.7$

$T_{total} \text{ (°R)} = 1225$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

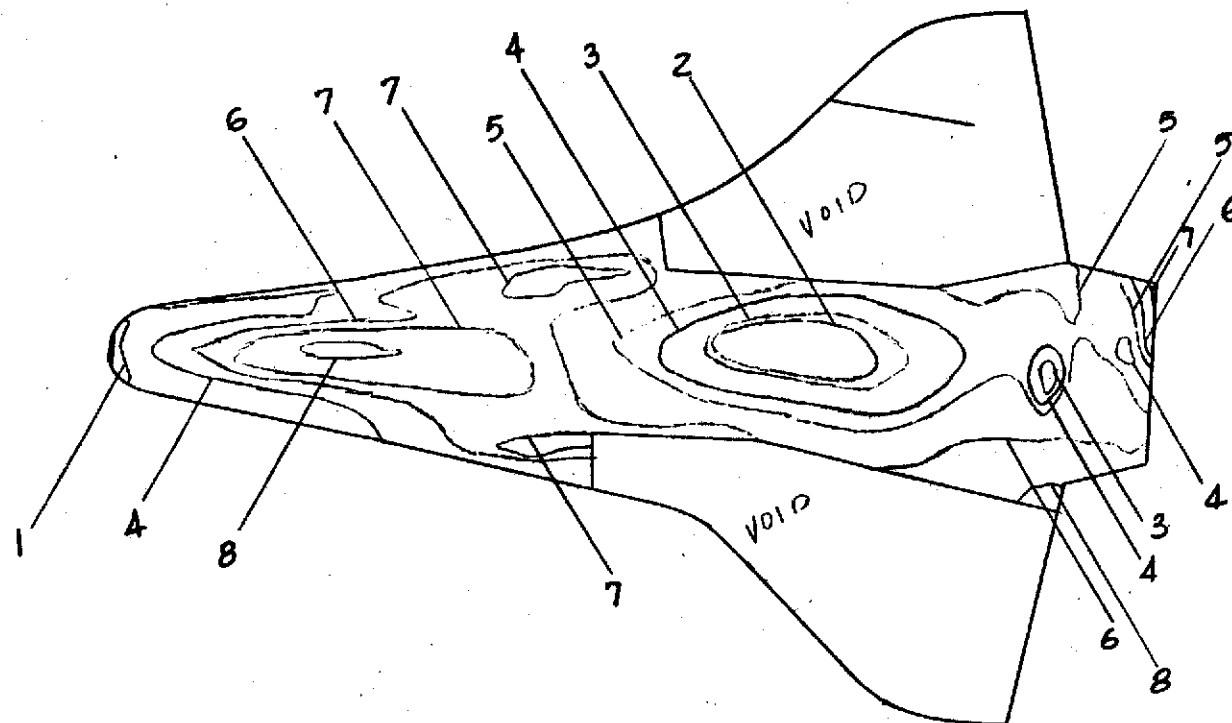
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	2994
2	1516
3	1497
4	1412
5	1313
6	1124
7	.0998
8	.0864
9	
10	

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FIGURE 110

## CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3824

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1330$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

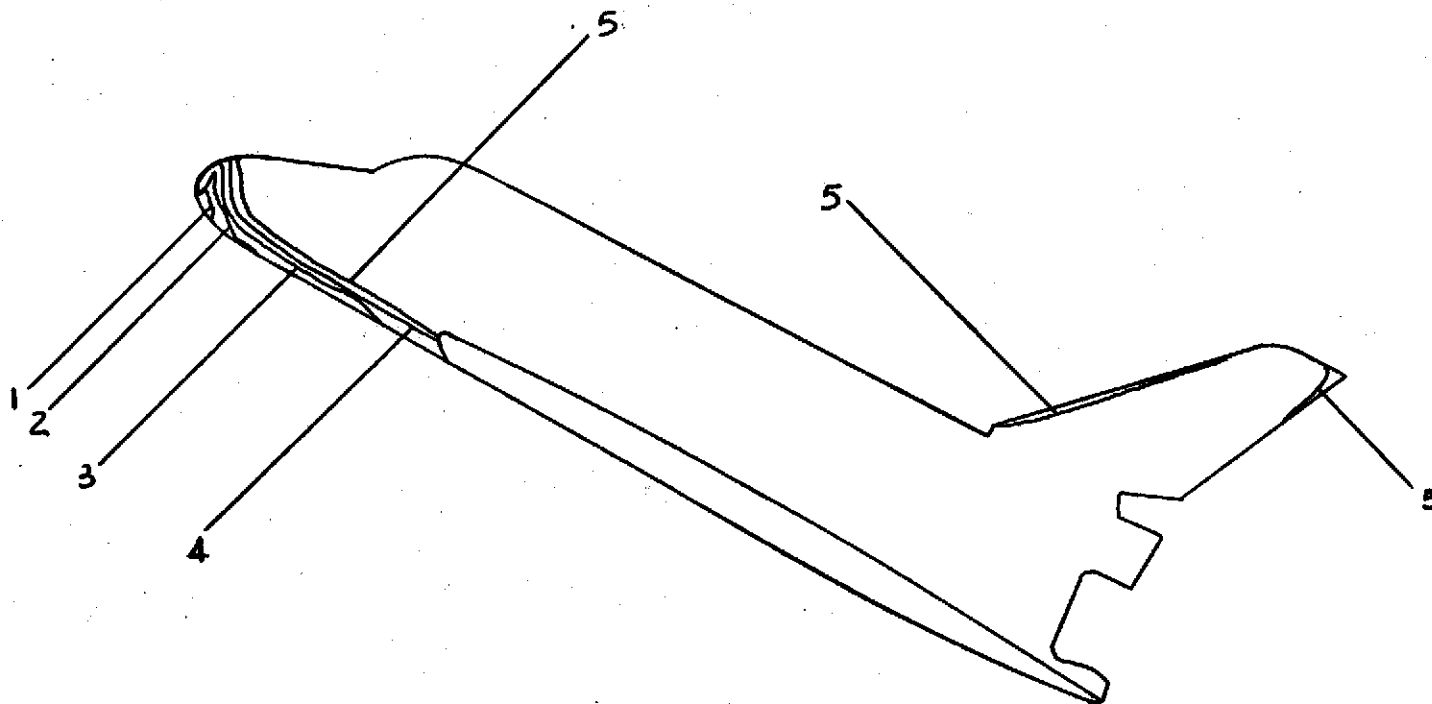
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.3079
2	.2177
3	.1646
4	.1257
5	.0908
6	
7	
8	
9	
10	

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FIGURE 111

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3824

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (°R)} = 1330$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

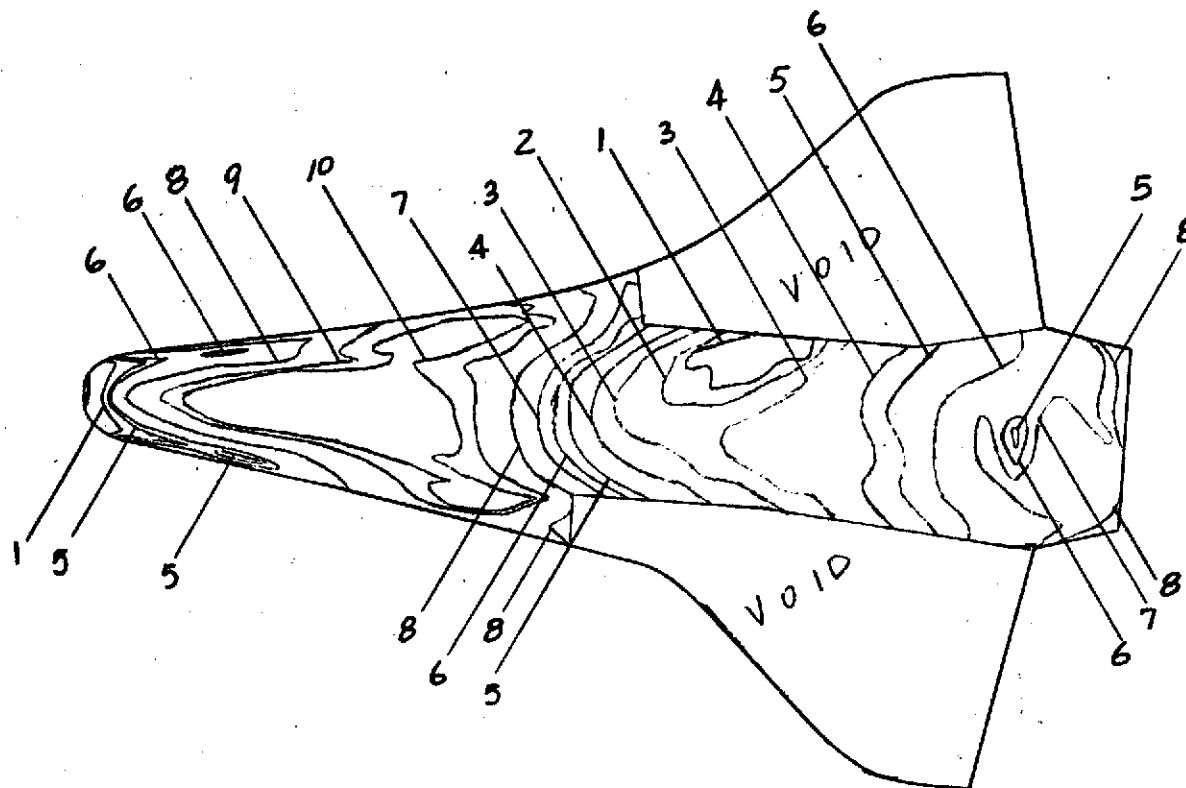
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2469
2	.2403
3	.2285
4	.2138
5	.1945
6	.1823
7	.1656
8	.1425
9	.1201
10	.1110

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FIGURE 112

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3825

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1375$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

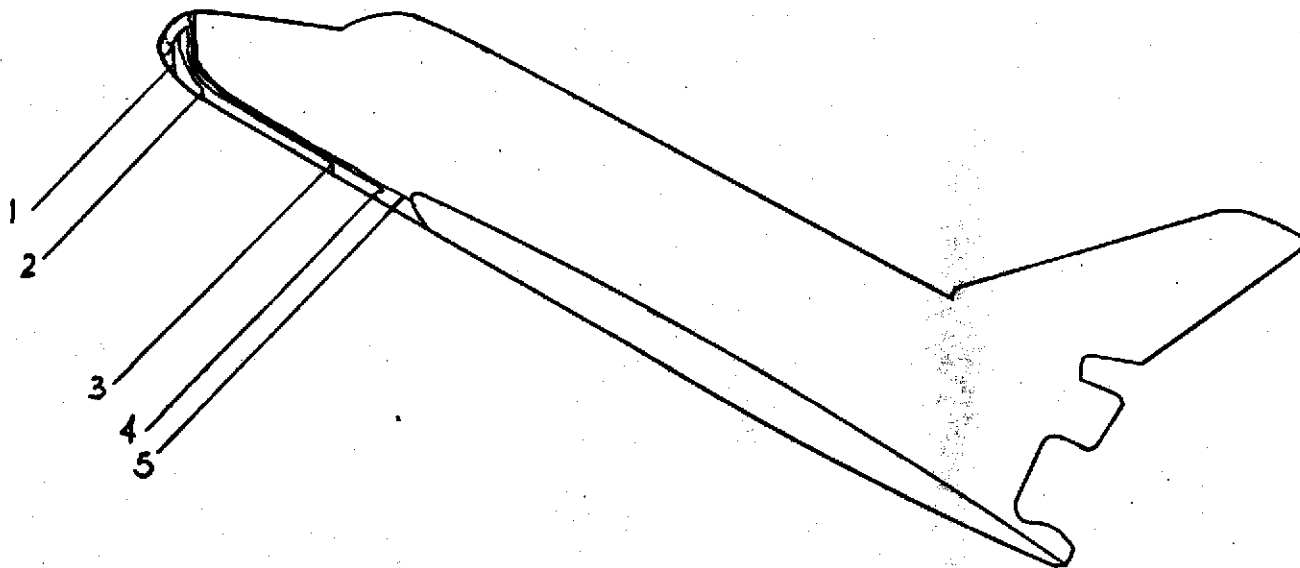
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1'}$
1	.3422
2	.2164
3	.1711
4	.1397
5	.1174
6	
7	
8	
9	
10	

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FIGURE 113

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3825

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (}^\circ\text{R)} = 1375$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 400$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

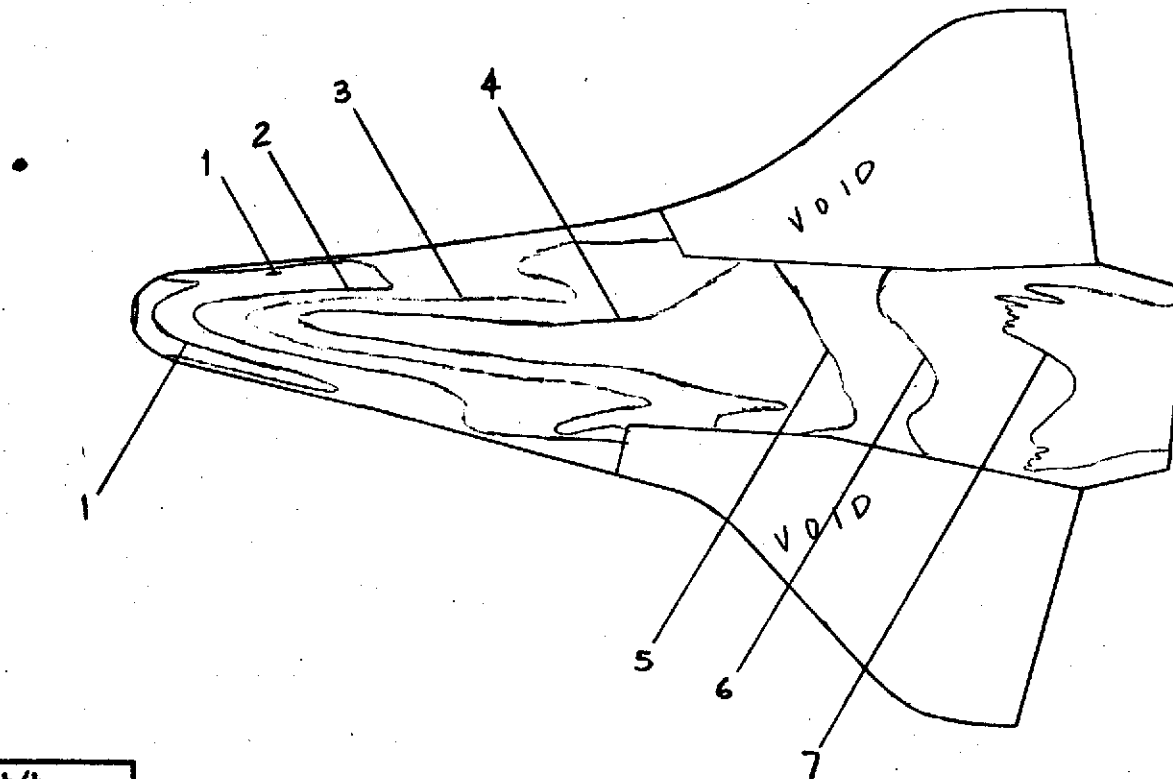
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1431
2	.1012
3	.0871
4	.0754
5	.0653
6	.0557
7	.0392
8	
9	
10	

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FIGURE 114

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3826

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 179.7$

$T_{total} \text{ (}^\circ\text{R)} = 1245$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

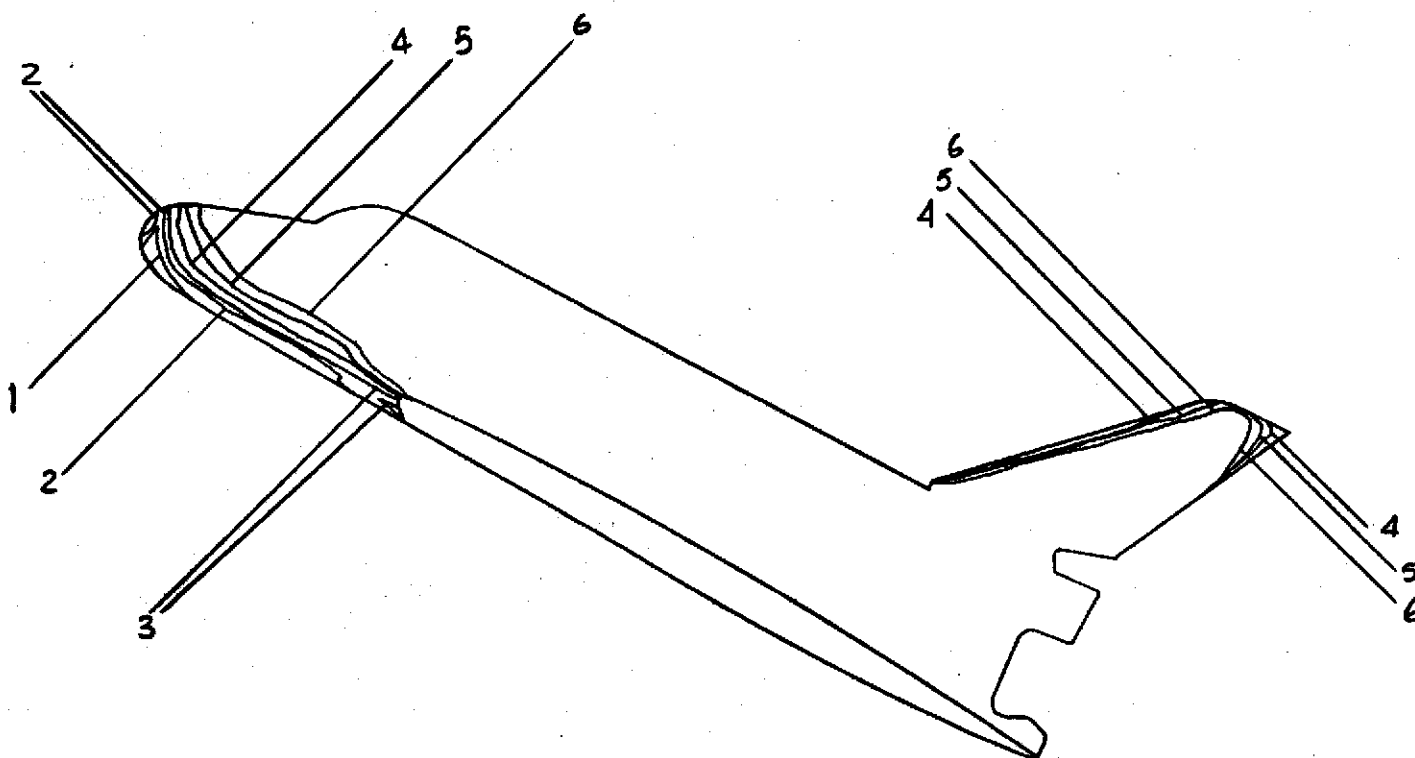
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.1751
2	.1238
3	.1036
4	.0655
5	.1145
6	.0392
7	
8	
9	
10	

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FIGURE 115

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3826

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 179.7$

$T_{\text{total}} \text{ (}^{\circ}\text{R)} = 1245$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 150$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

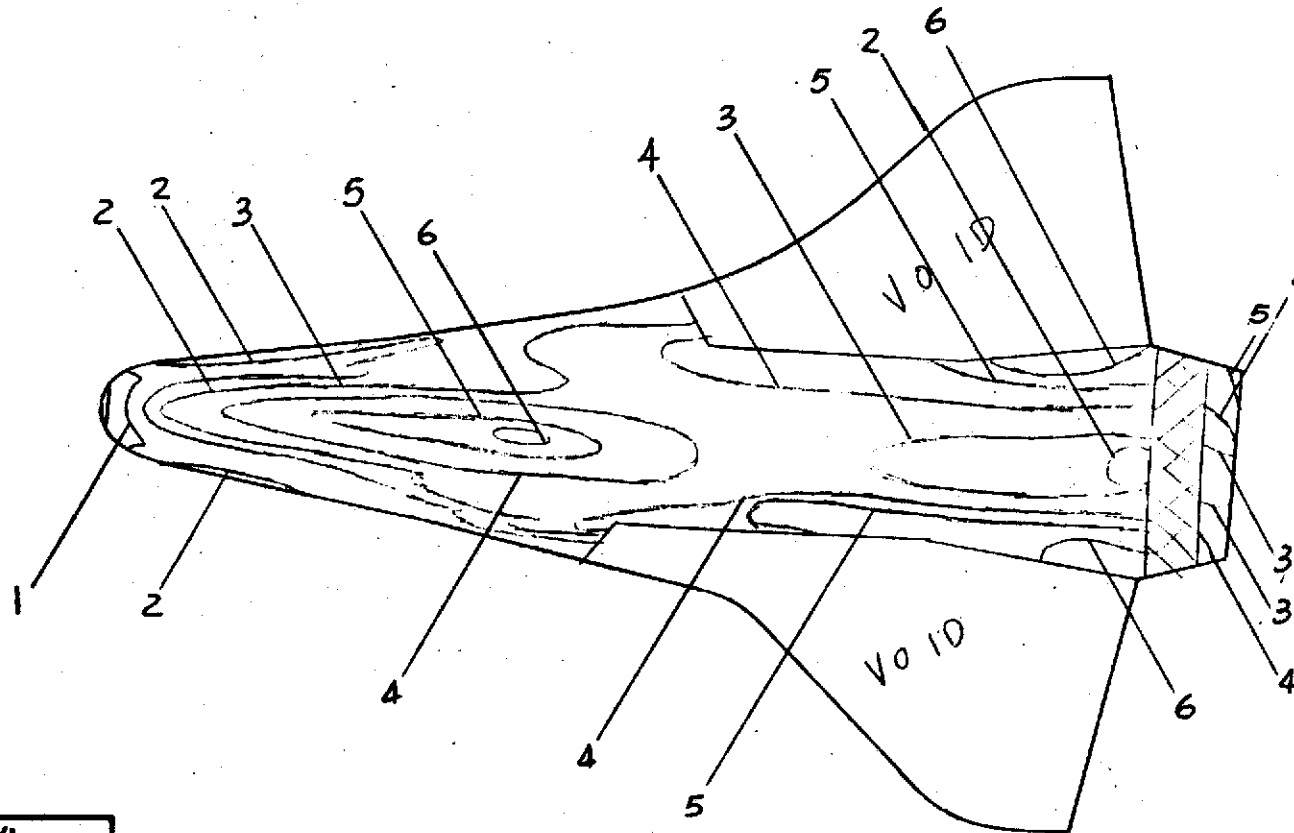
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{F=1}$
1	.2220
2	.1404
3	.1170
4	.0938
5	.0800
6	.0724
7	
8	
9	
10	

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FIGURE 116

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3827

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (°R)} = 1310$

$T_{aw}/T_{total} = .898$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 250$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

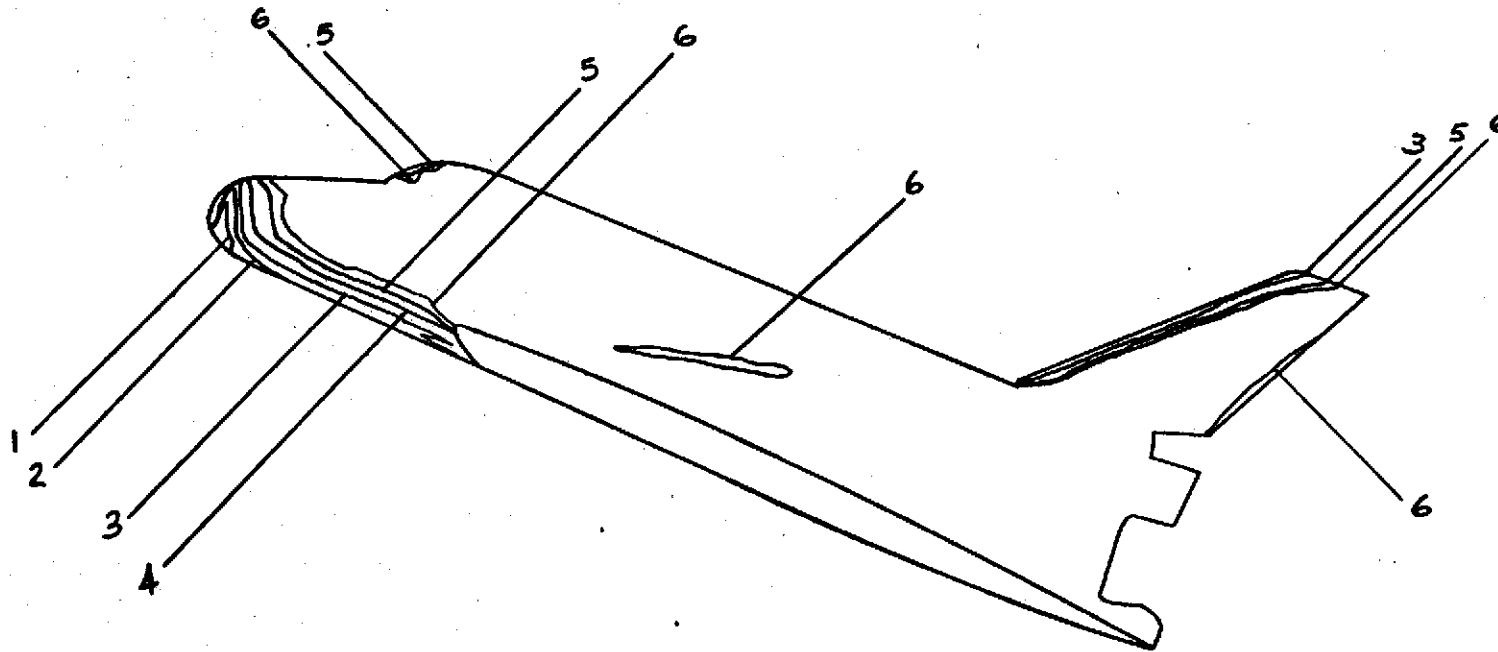
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.2600
2	.1866
3	.1397
4	.0988
5	.0736
6	.0651
7	
8	
9	
10	

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FIGURE 117

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3827

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (°R)} = 1310$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 250$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

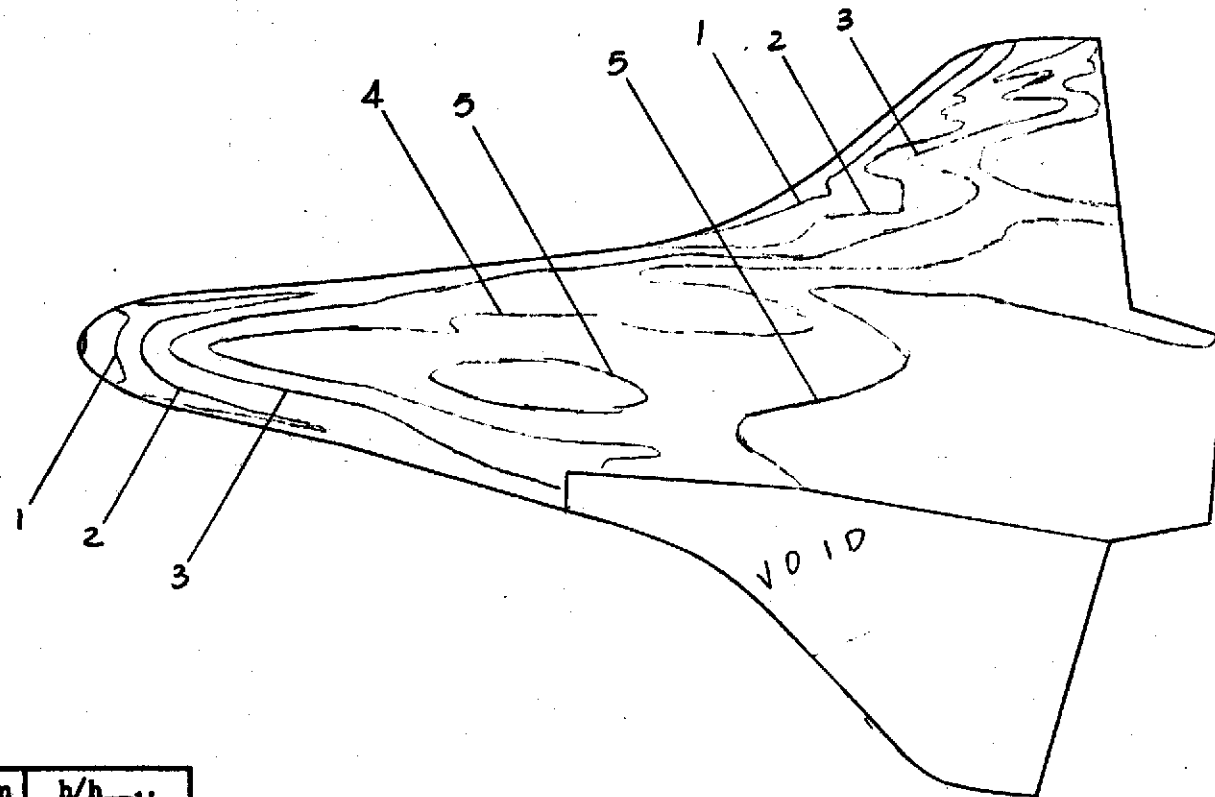
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.2220
2	.1532
3	.1110
4	.0876
5	.0646
6	
7	
8	
9	
10	

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FIGURE 118

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3828

$M_{\bullet} = 7.9$

$P_{total} \text{ (psia)} = 649.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1310$

$T_{aw}/T_{total} = .898$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 250$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

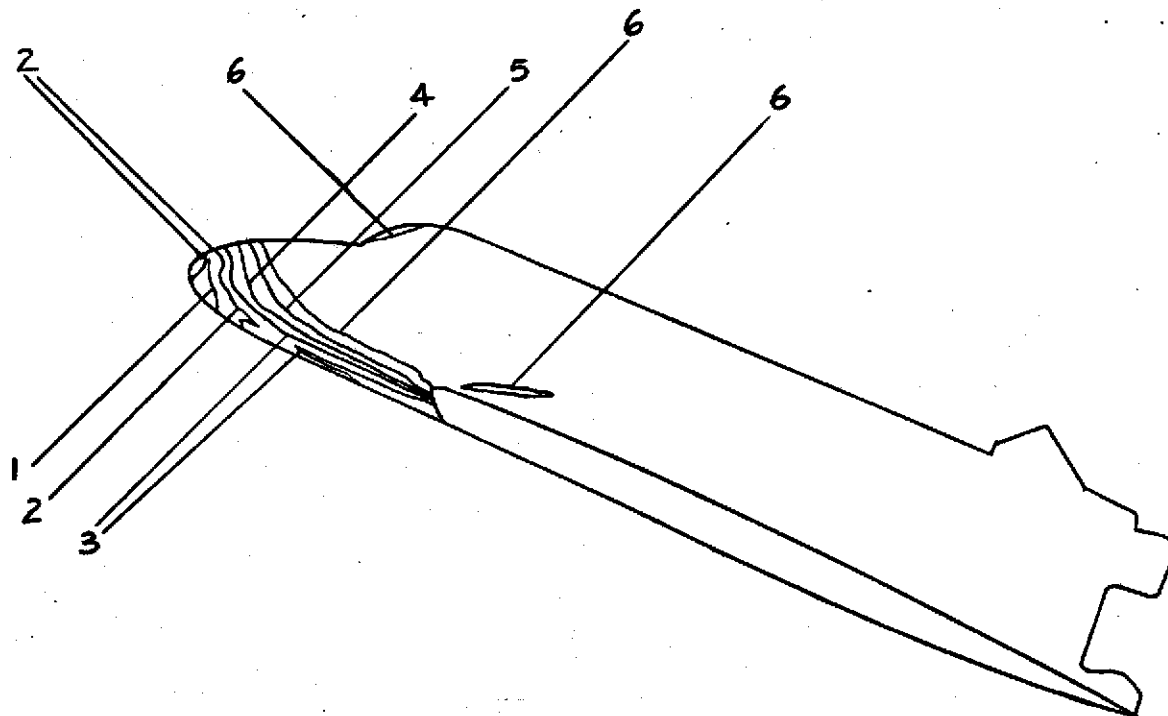
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.2640
2	.1803
3	.1397
4	.0988
5	.0757
6	.0651
7	
8	
9	
10	

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FIGURE 119

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3828

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 649.7

$T_{total}$  (°R) = 1310

$T_{aw}/T_{total}$  = .90

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 250

$\alpha$  = 25

$\beta$  = 0

$\phi$  = 180

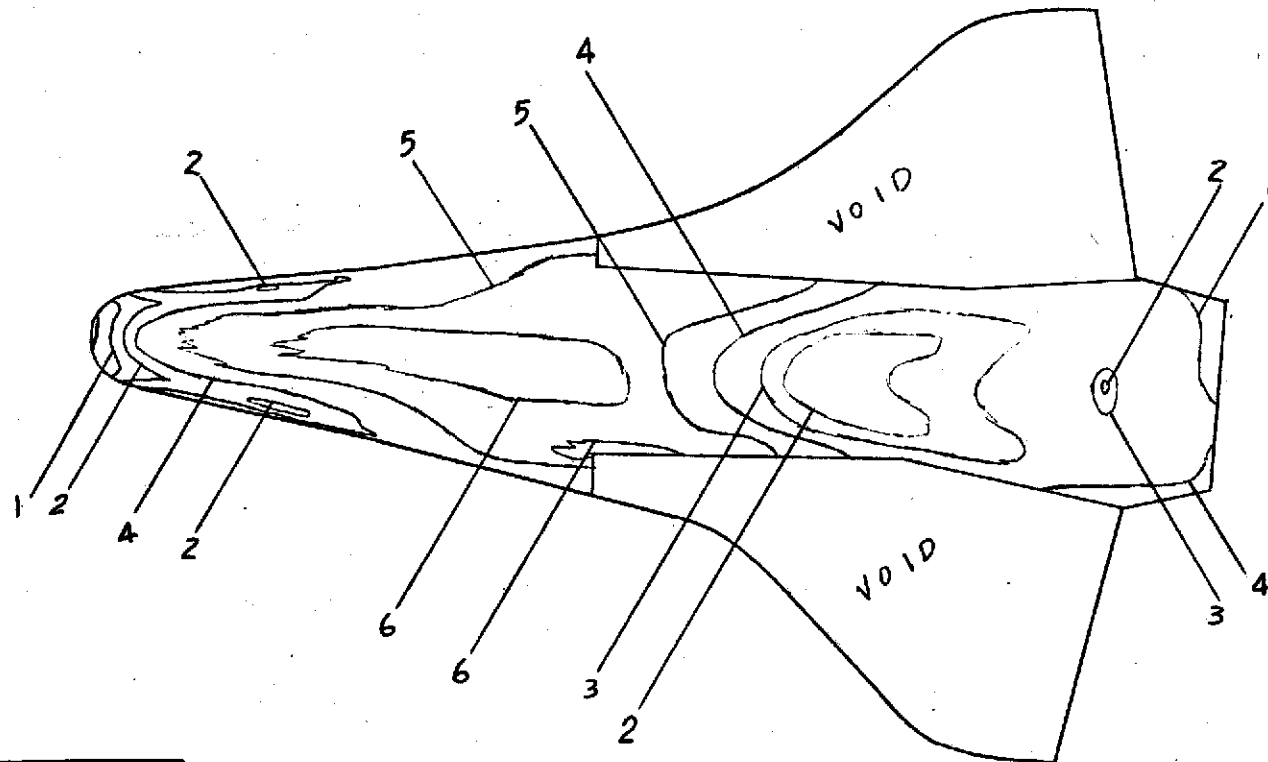
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2818
2	.1993
3	.1782
4	.1528
5	.1151
6	.0850
7	
8	
9	
10	

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FIGURE 120

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3829

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (}^\circ\text{R)} = 1345$

$T_{aw}/T_{total} = .898$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

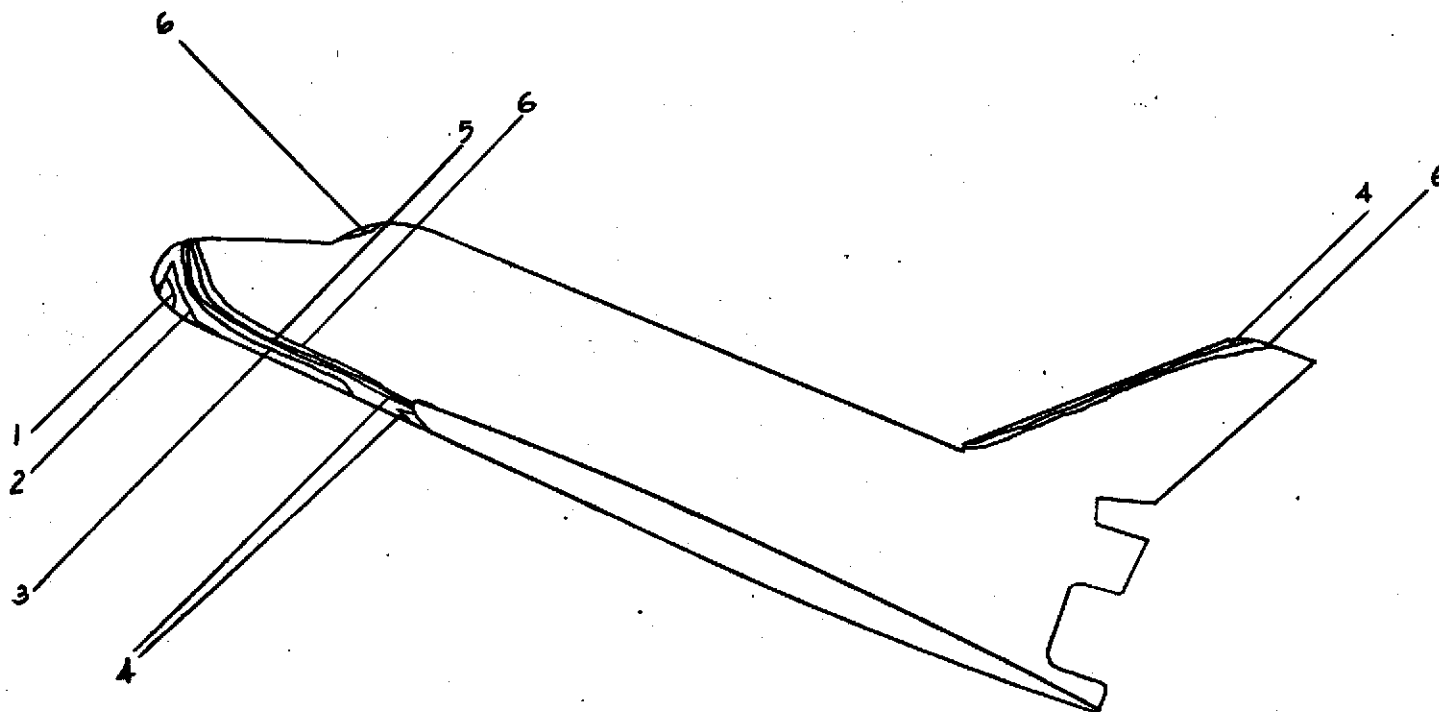
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3348
2	.2287
3	.1617
4	.1253
5	.1023
6	.0864
7	
8	
9	
10	

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FIGURE 121

## CONFIG.

LENGTH (R) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3829

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1345$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 350$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

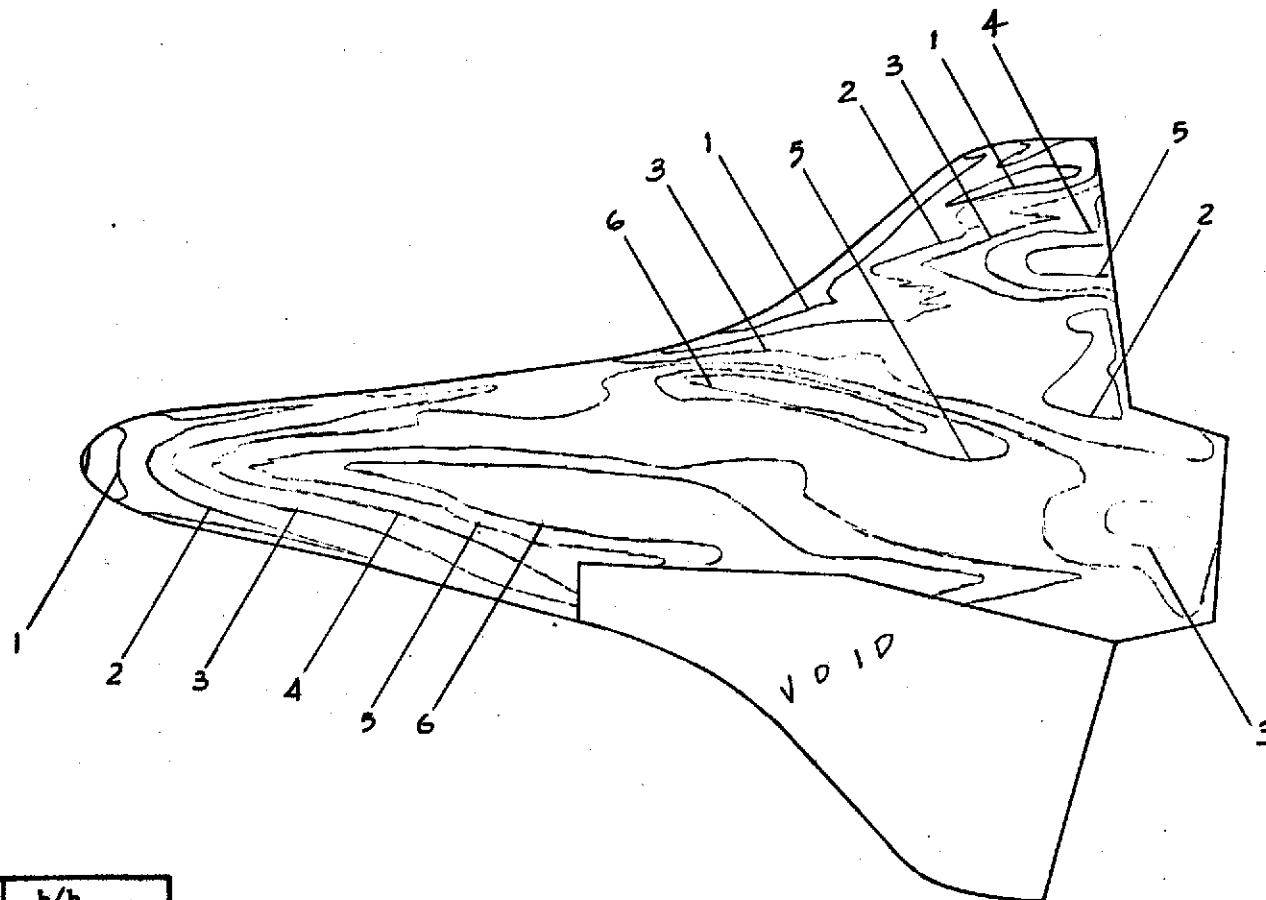
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.2544
2	.1578
3	.1213
4	.0998
5	.0853
6	.0767
7	
8	
9	
10	

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FIGURE 122

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3830

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 1394.7

$T_{total}$  ( $^{\circ}$ R) = 1395

$T_{aw}/T_{total}$  = .898

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) = 350

$\alpha$  = 25

$\beta$  = 0

$\phi$  = 180

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

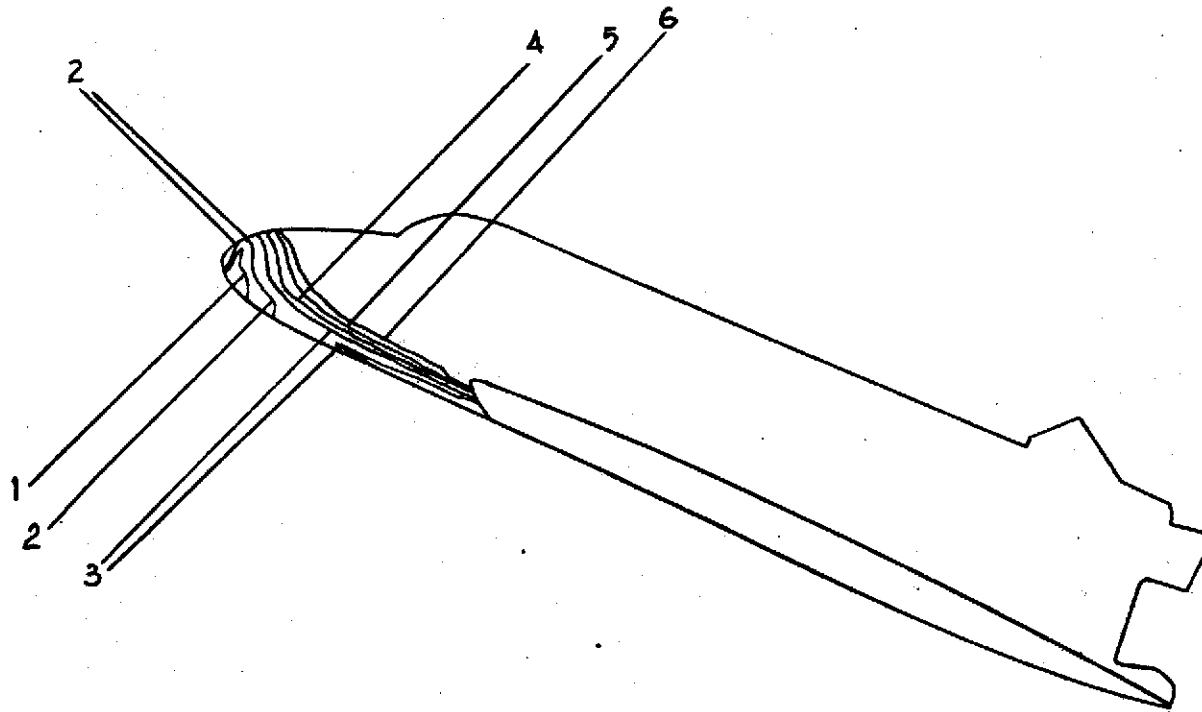
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3023
2	.2065
3	.1460
4	.1131
5	.0892
6	.0780
7	
8	
9	
10	

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FIGURE 123

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3830

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (°R)} = 1395$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 350$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

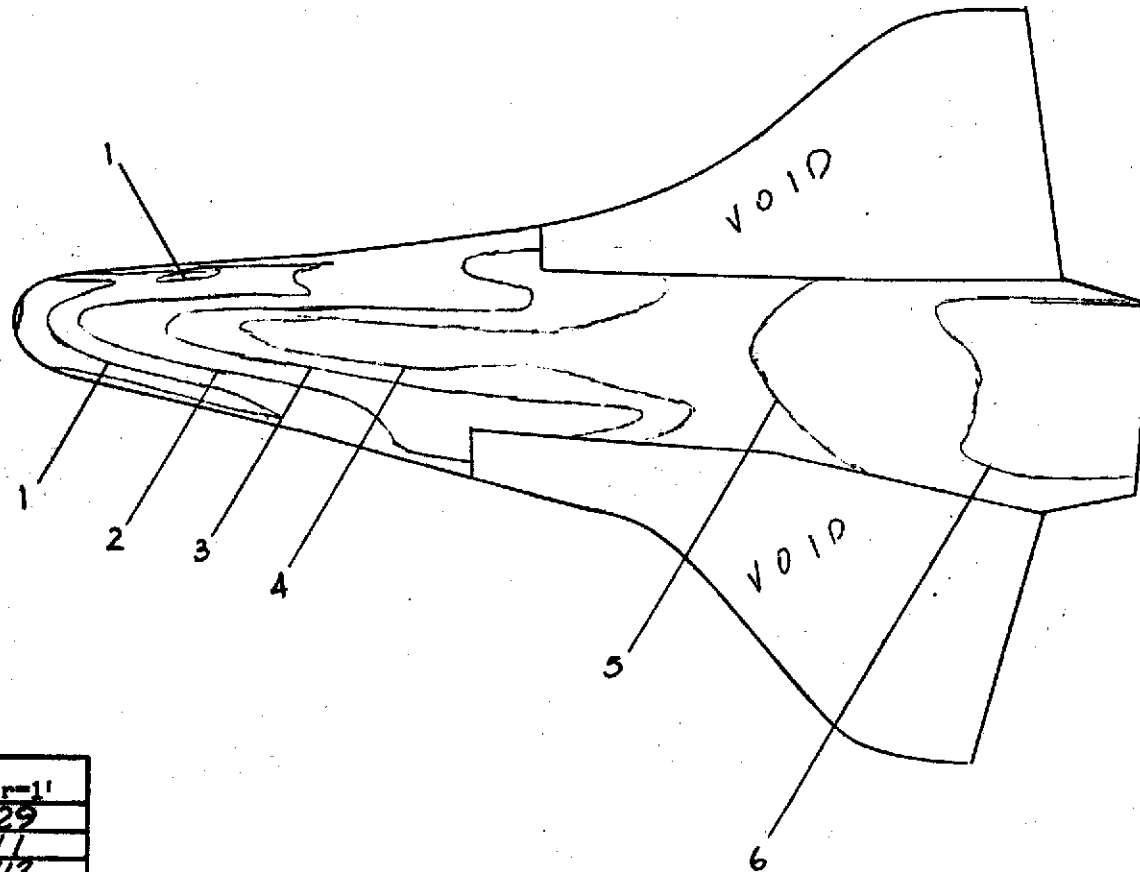
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1429
2	.1011
3	.0813
4	.0691
5	.0588
6	.0390
7	
8	
9	
10	

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FIGURE 124

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3832

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^\circ\text{R)} = 1250$

$T_{aw}/T_{total} = .898$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (}^\circ\text{F)} = 150$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

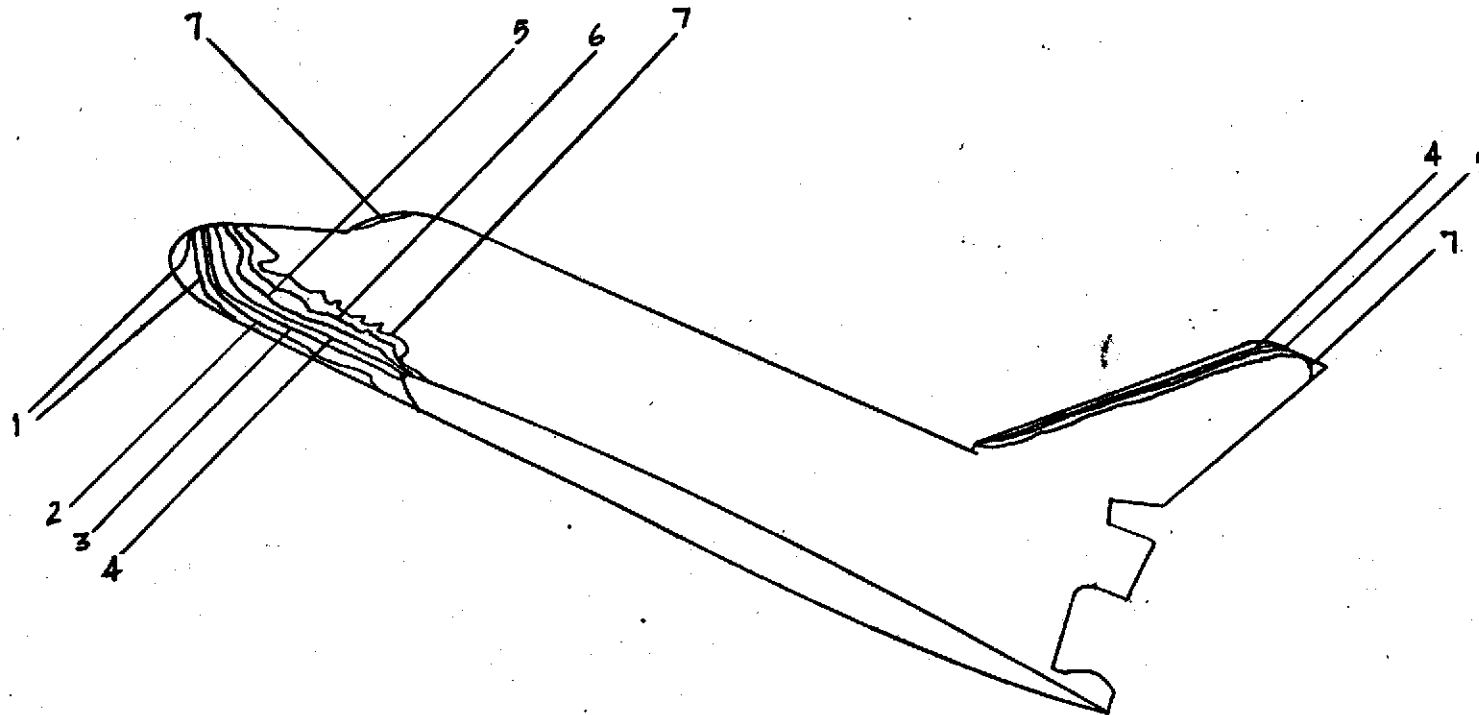
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.1668
2	.1218
3	.0943
4	.0667
5	.0527
6	.0450
7	.0399
8	
9	
10	

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FIGURE 125

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3832

$M_\infty = 7.9$

$P_{total}$  (psia) = 174.7

$T_{total}$  ( $^{\circ}R$ ) = 1250

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 150

$\alpha = 25$

$\beta = 0$

$\phi = 180$

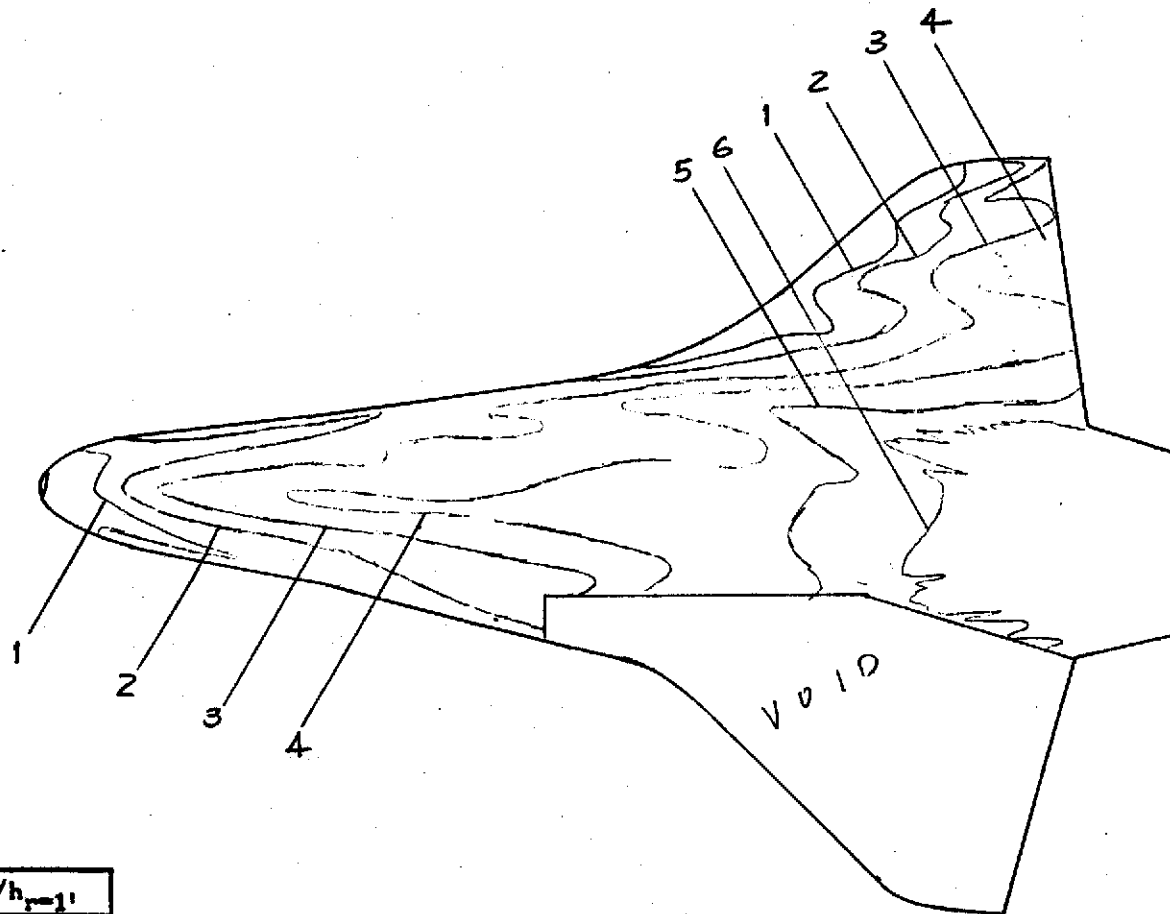
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.1518
2	.1102
3	.0824
4	.0679
5	.0527
6	.0396
7	
8	
9	
10	

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FIGURE 126

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3833

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 174.7$

$T_{\text{total}} \text{ (°R)} = 1235$

$T_{\text{aw}}/T_{\text{total}} = .898$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 150$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

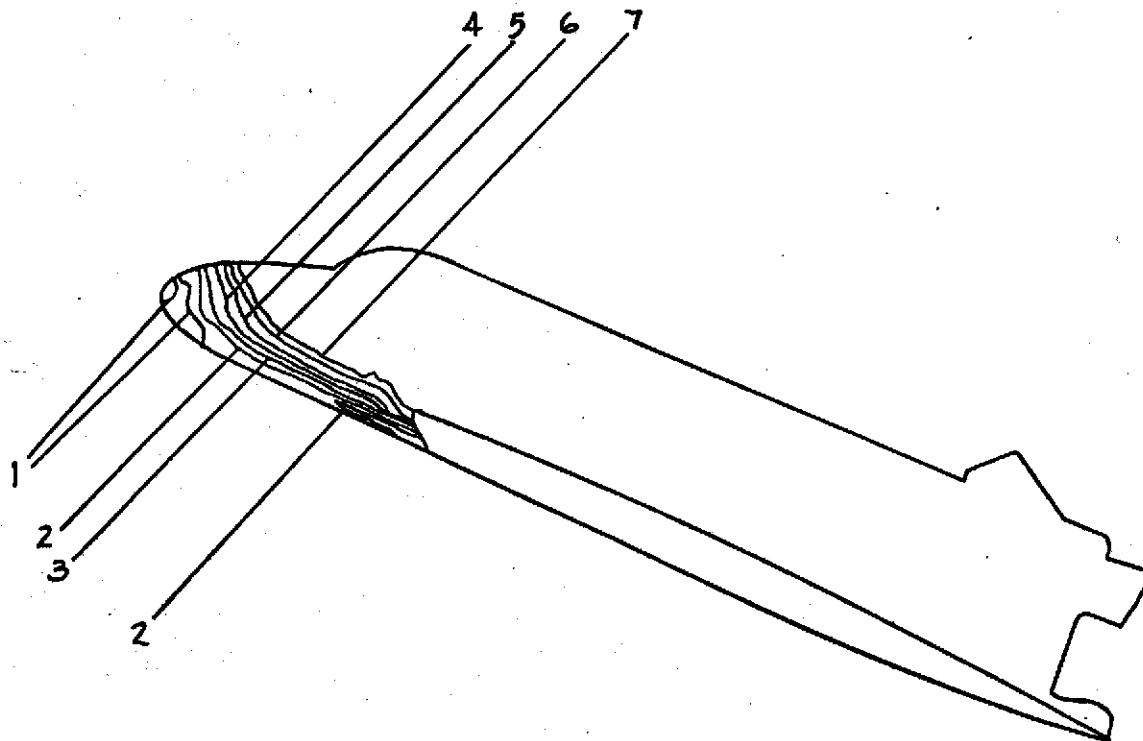
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{-1}$
1	.1806
2	.1234
3	.0956
4	.0676
5	.0534
6	.0456
7	.0404
8	
9	
10	

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FIGURE 127

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3833

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^\circ\text{R)} = 1235$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 150$

$\alpha = 25$

$\beta = 0$

$\phi = 180$

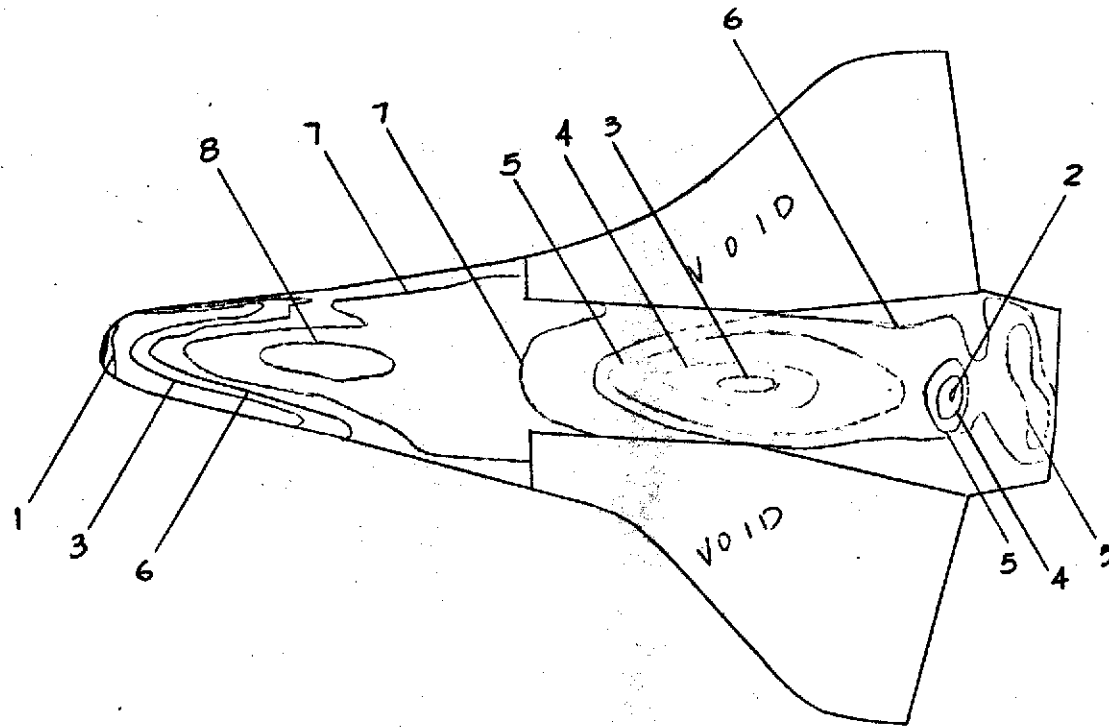
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2907
2	.1651
3	.1532
4	.1491
5	.1386
6	.1300
7	.1099
8	.0884
9	
10	

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FIGURE 128

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3834

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (}^\circ\text{R)} = 1320$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

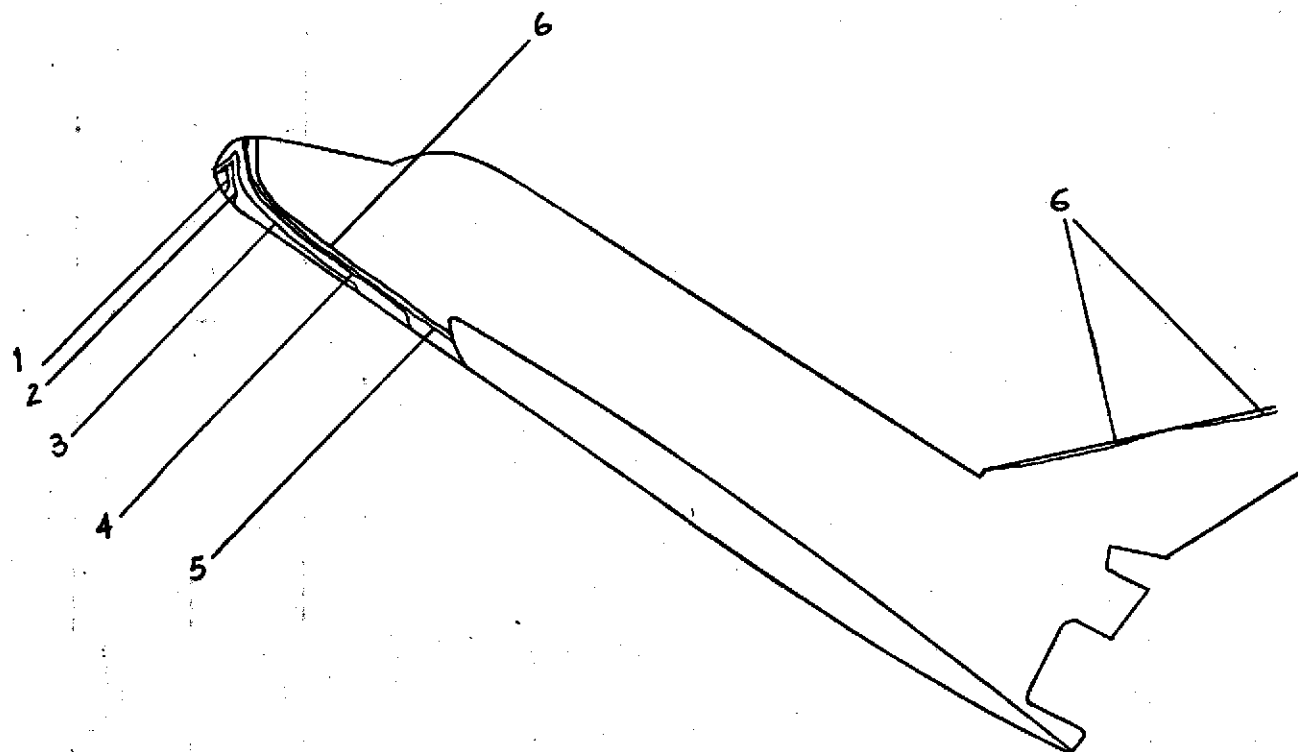
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.3674
2	.2510
3	.1746
4	.1375
5	.1162
6	.0972
7	
8	
9	
10	

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FIGURE 129

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3834

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1320$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

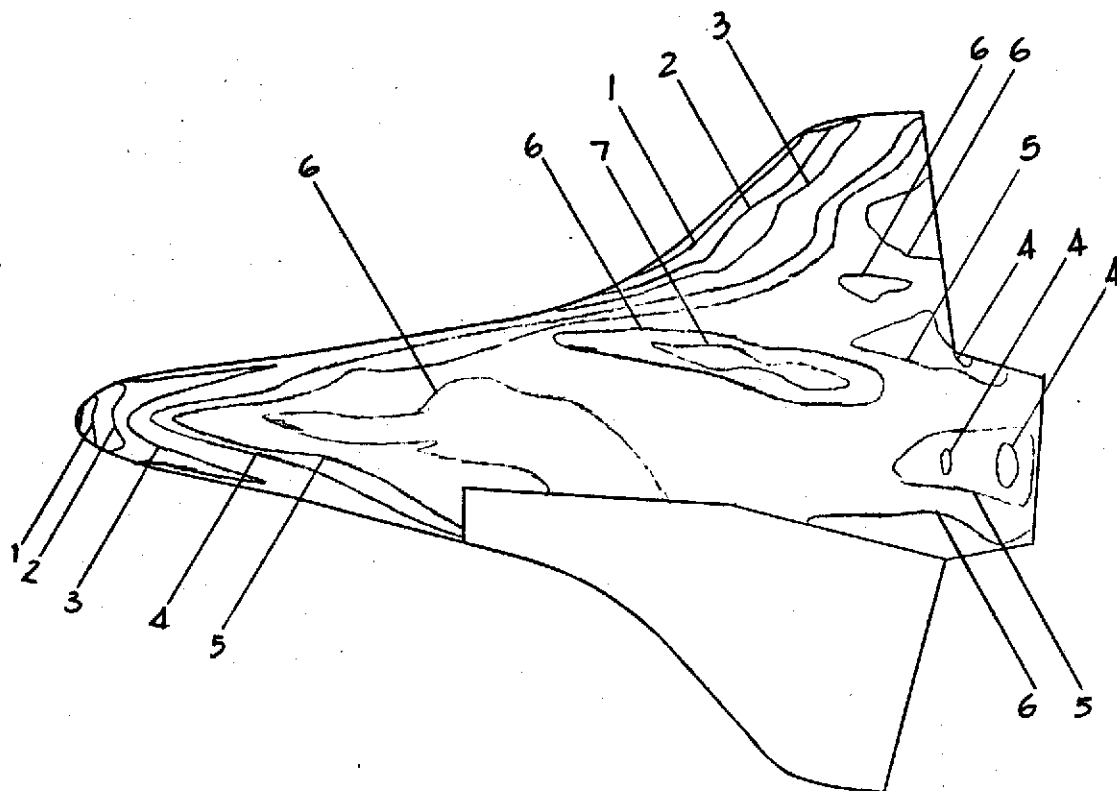
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{film1}$
1	.2891
2	.1939
3	.1466
4	.1139
5	.1029
6	.0919
7	.0802
8	
9	
10	

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FIGURE 130

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3835

$M_{\infty}$  = 7.9

$P_{total}$  (psia) = 639.7

$T_{total}$  (°R) = 1360

$T_{aw}/T_{total}$  = .92

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 300

$\alpha$  = 35

$\beta$  = 0

$\phi$  = 180

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

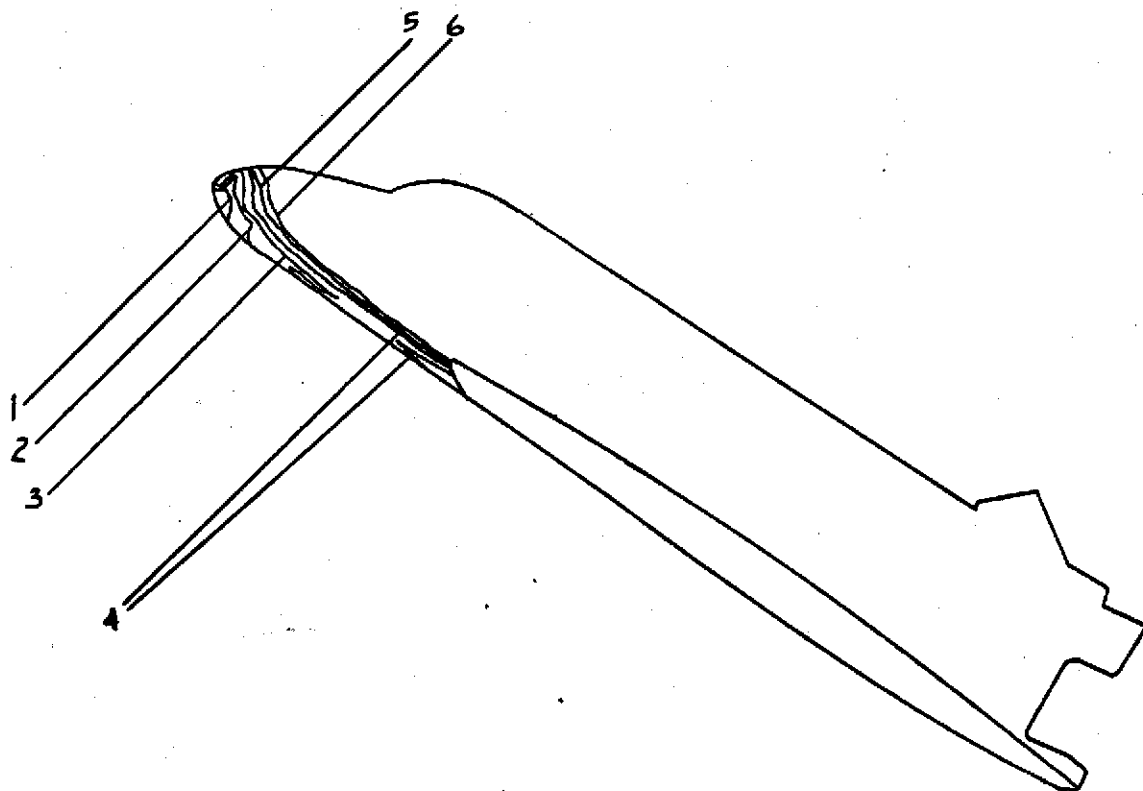
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{\text{max}}$
1	.3458
2	.2362
3	.1670
4	.1294
5	.1023
6	.0872
7	
8	
9	
10	

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FIGURE 131

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3835

$M_{\text{a}} = 7.9$

$P_{\text{total}}$  (psia) = 639.7

$T_{\text{total}}$  ( $^{\circ}\text{R}$ ) = 1360

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N$  per foot =

$T_{\text{phase change}}$  ( $^{\circ}\text{F}$ ) = 300

$\alpha = 35$

$\beta = 0$

$\phi = 180$

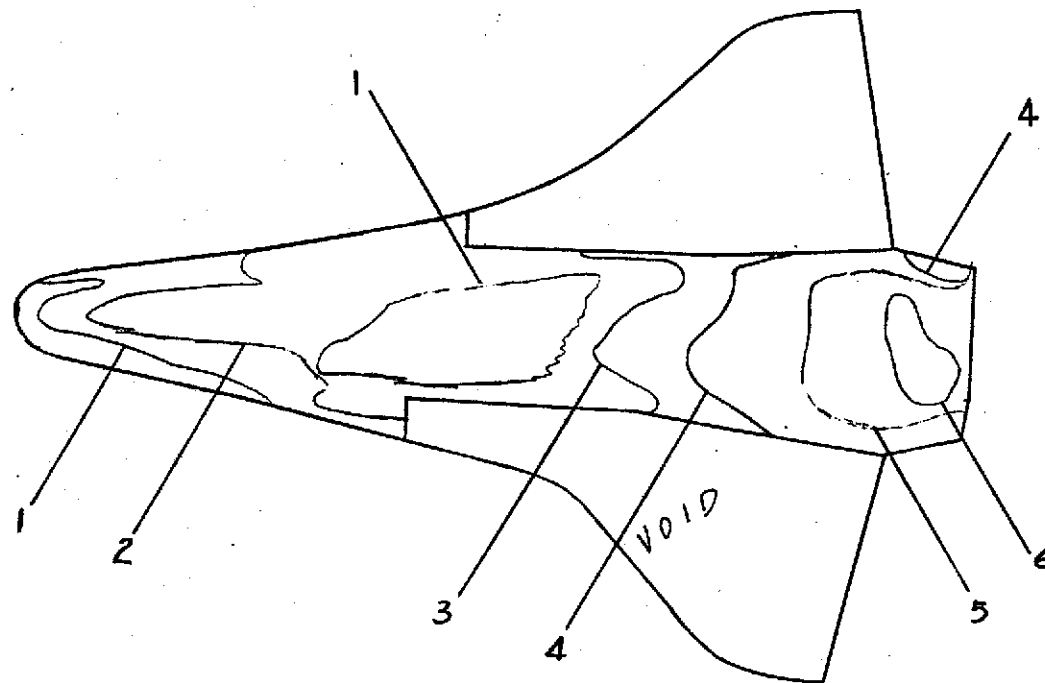
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{x=1}$
1	.1580
2	.1080
3	.0728
4	.0574
5	.0446
6	.0377
7	
8	
9	
10	

PAGE 158  
FIGURE 132

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3836

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (°R)} = 1355$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 150$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

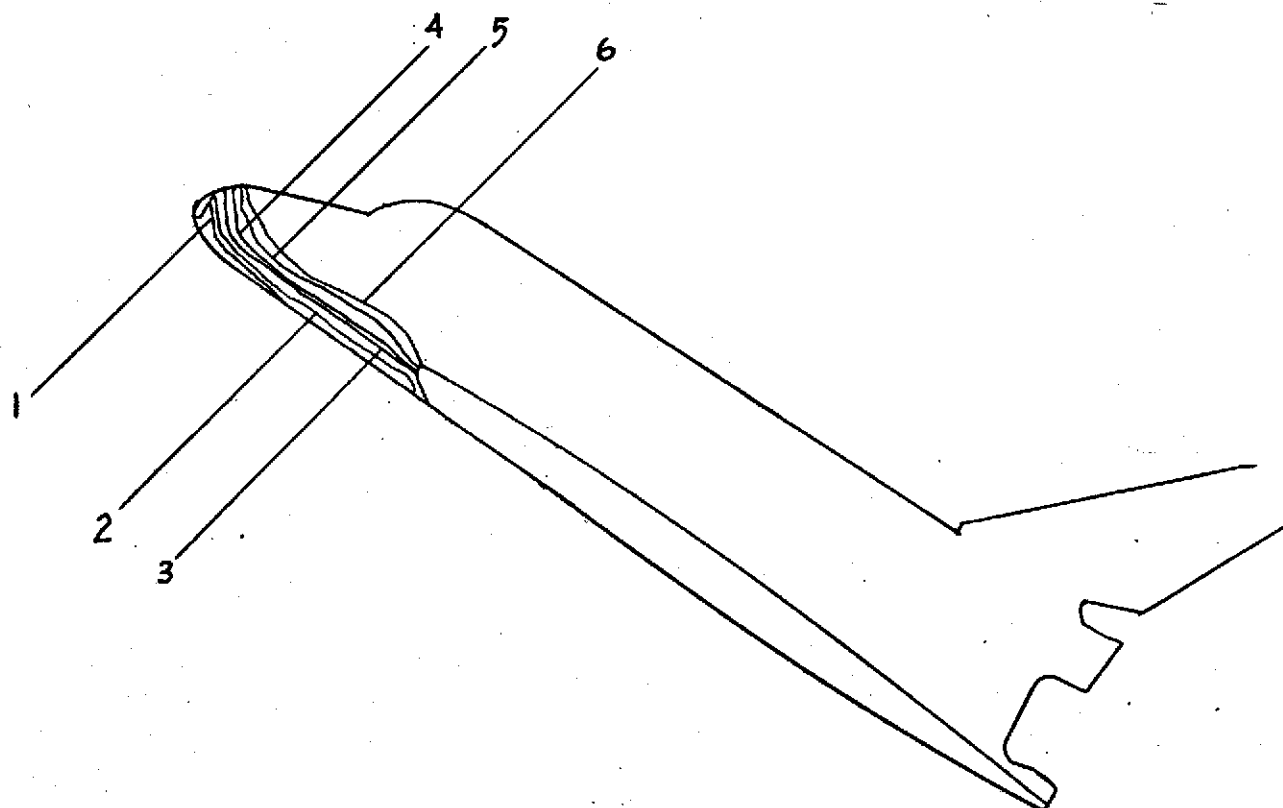
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1648
2	.1166
3	.0796
4	.0617
5	.0460
6	.0369
7	
8	
9	
10	

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FIGURE 133

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3836

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (°R)} = 1355$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 150$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

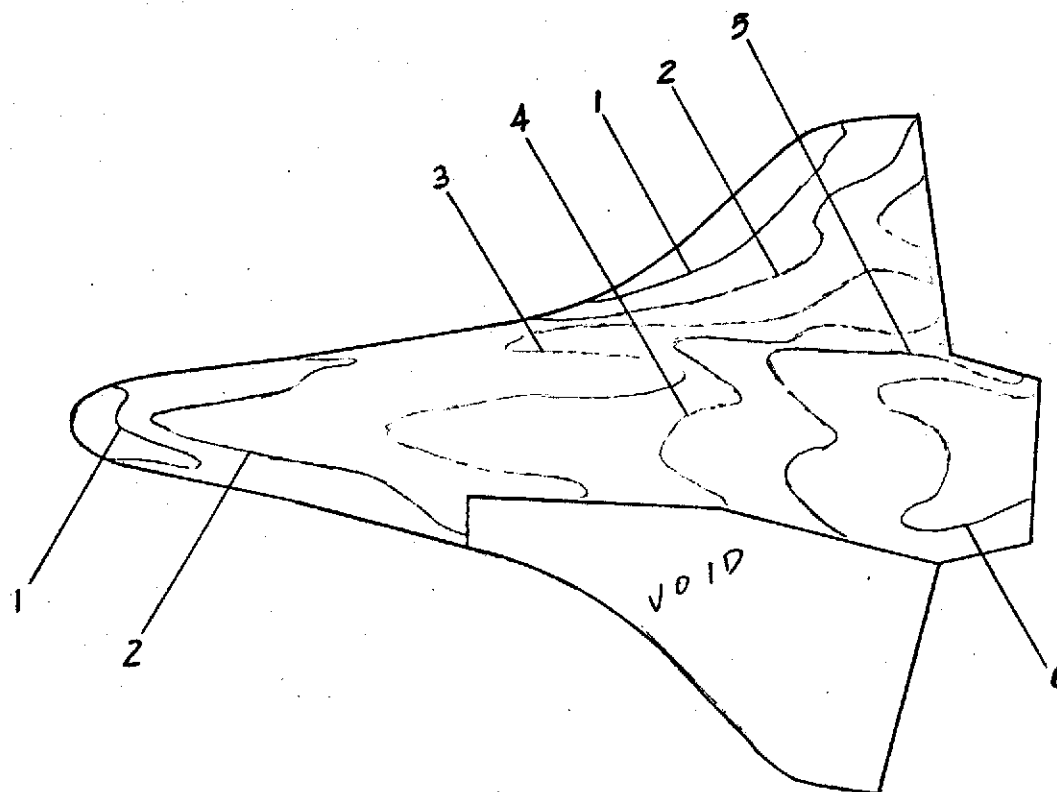
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.1380
2	.0930
3	.0738
4	.0623
5	.0488
6	.0378
7	
8	
9	
10	

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FIGURE 134

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3837

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 174.7

$T_{total}$  ( $^{\circ}R$ ) = 1310

$T_{aw}/T_{total} = .92$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 150

$\alpha = 35$

$\beta = 0$

$\phi = 180$

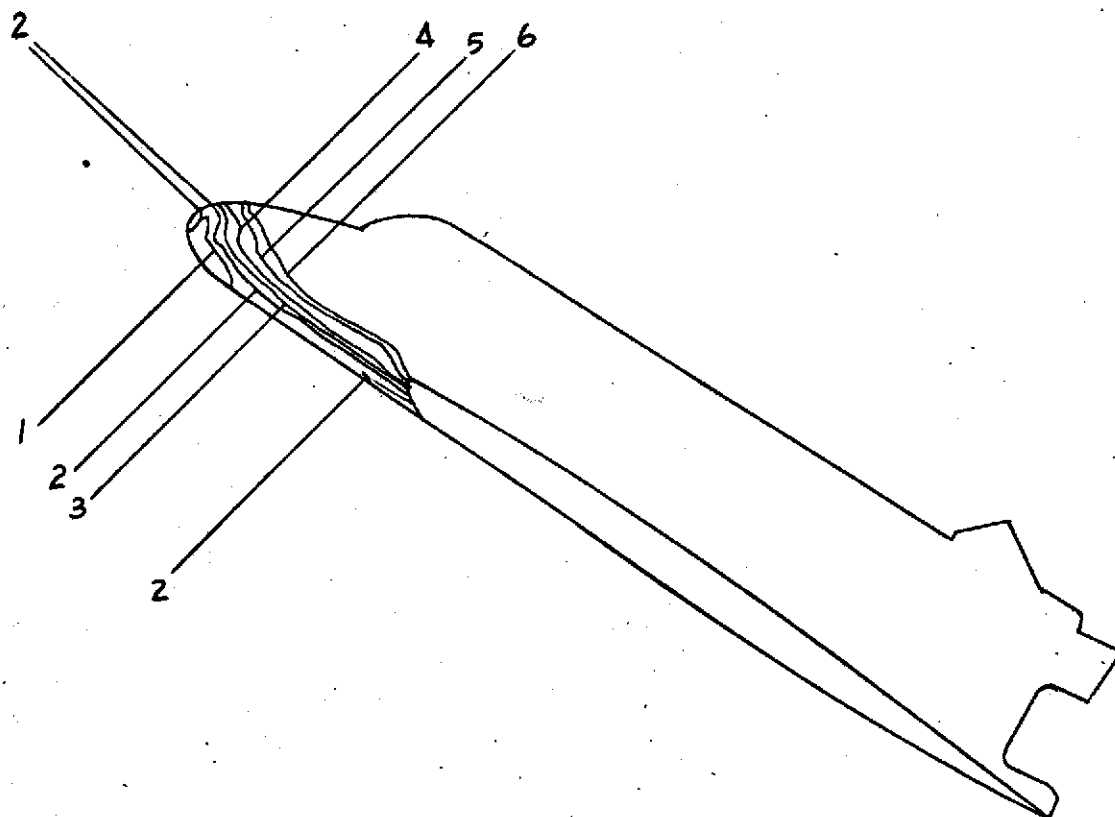
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1724
2	.1177
3	.0912
4	.0645
5	.0481
6	.0385
7	
8	
9	
10	

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FIGURE 135

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3837

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 174.7$

$T_{\text{total}} \text{ (}^{\circ}\text{R)} = 1310$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 150$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

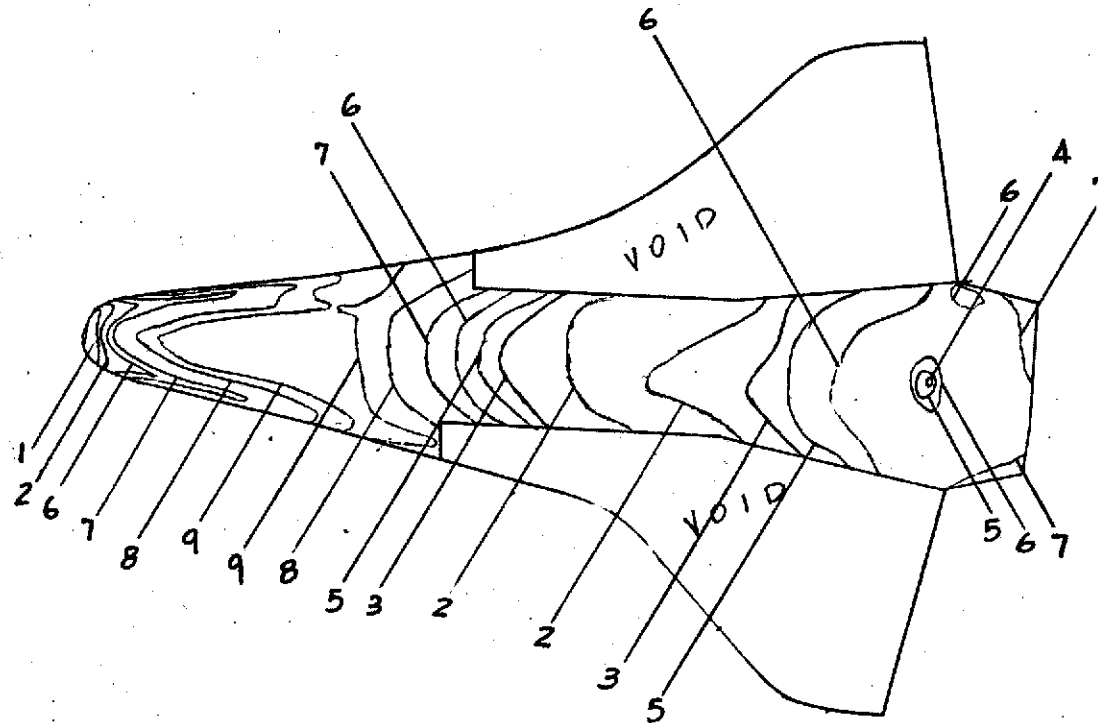
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3119
2	.2303
3	.2161
4	.2119
5	.2079
6	.1881
7	.1667
8	.1291
9	.1145
10	

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FIGURE 136

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3838

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (°R)} = 1360$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 400$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

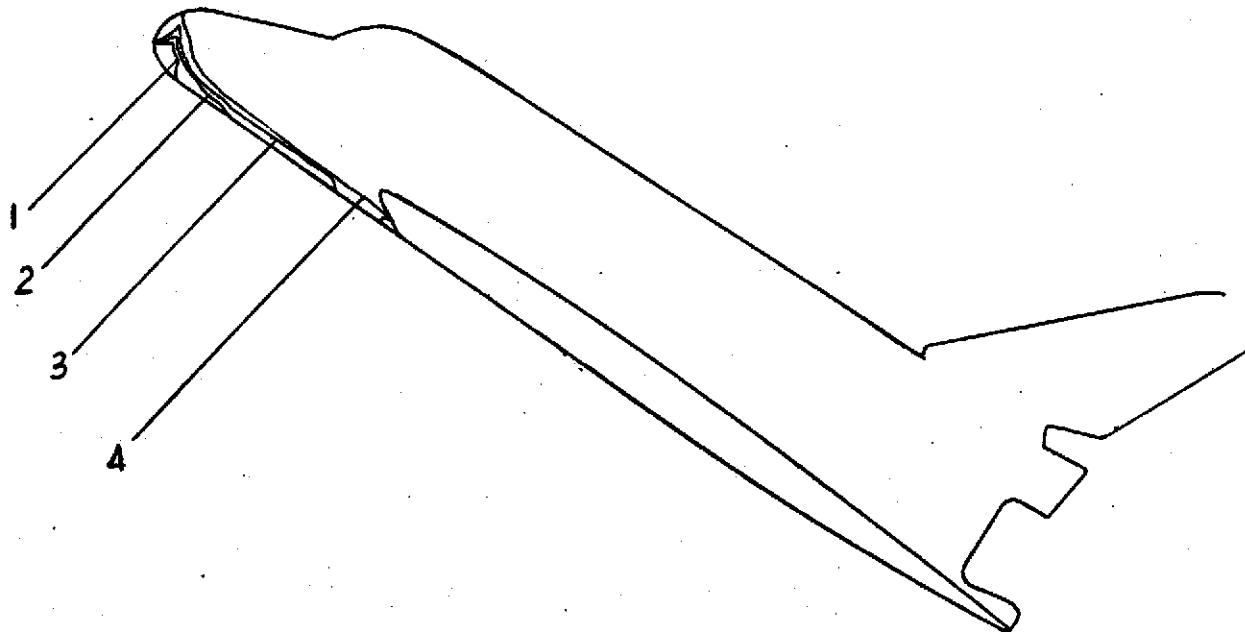
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.2580
2	.1824
3	.1489
4	.1244
5	
6	
7	
8	
9	
10	

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FIGURE 137

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3838

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1394.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1360$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

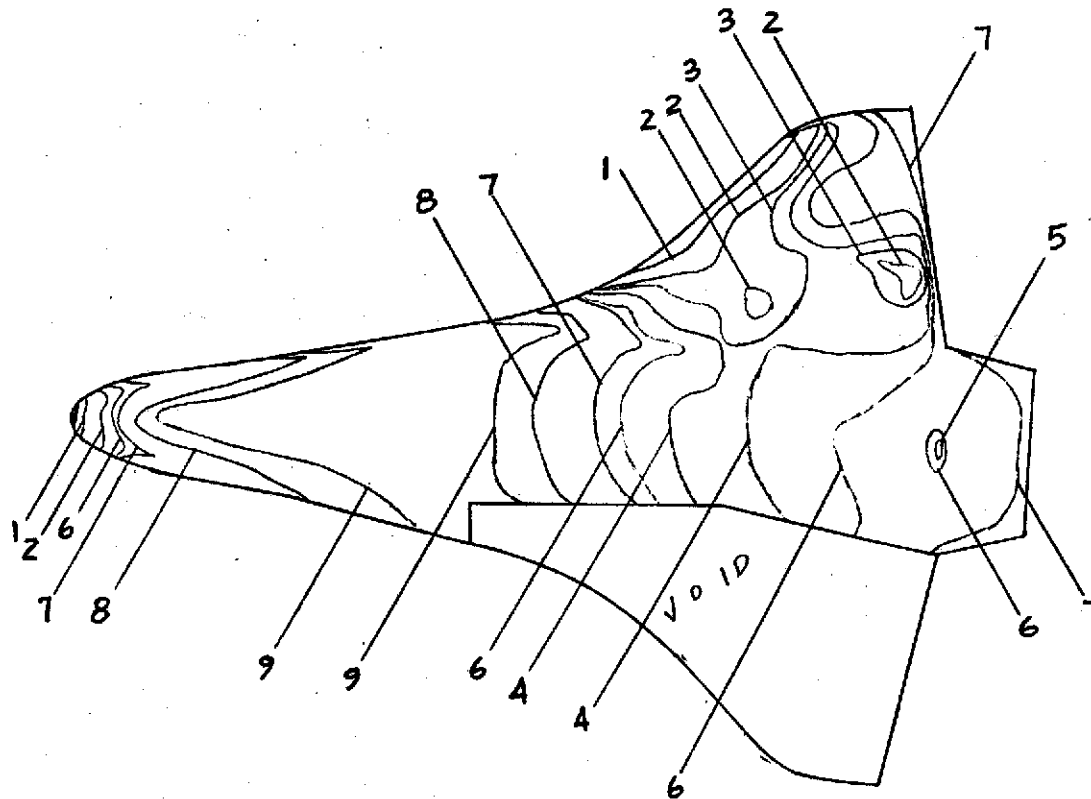
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	.3421
2	.2419
3	.2306
4	.2121
5	.2082
6	.2009
7	.1778
8	.1363
9	.1153
10	

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FIGURE 138

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3839

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (}^\circ\text{R)} = 1355$

$T_{aw}/T_{total} = .92$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 400$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from model center, x-axis parallel w/ stream, + downstream)

x (in) =

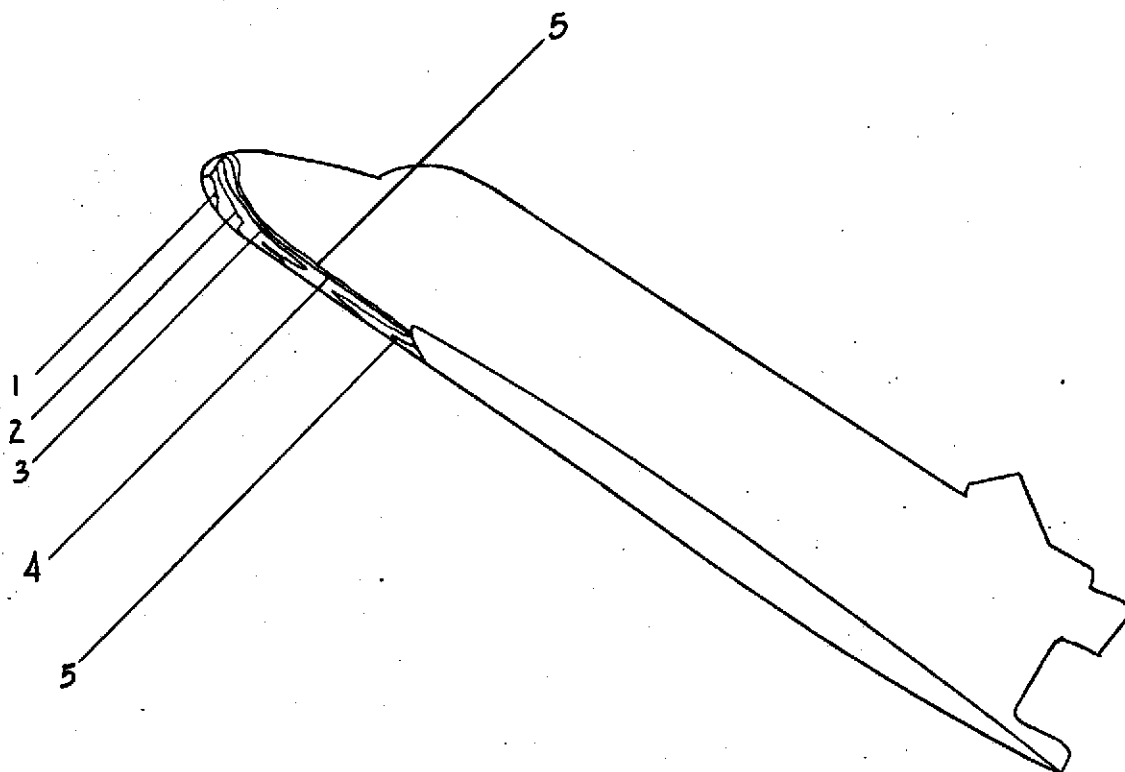
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3205
2	.2224
3	.1762
4	.1505
5	.1253
6	
7	
8	
9	
10	

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FIGURE 139

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3839

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 1424.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1355$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (}^{\circ}\text{F)} = 400$

$\alpha = 35$

$\beta = 0$

$\phi = 180$

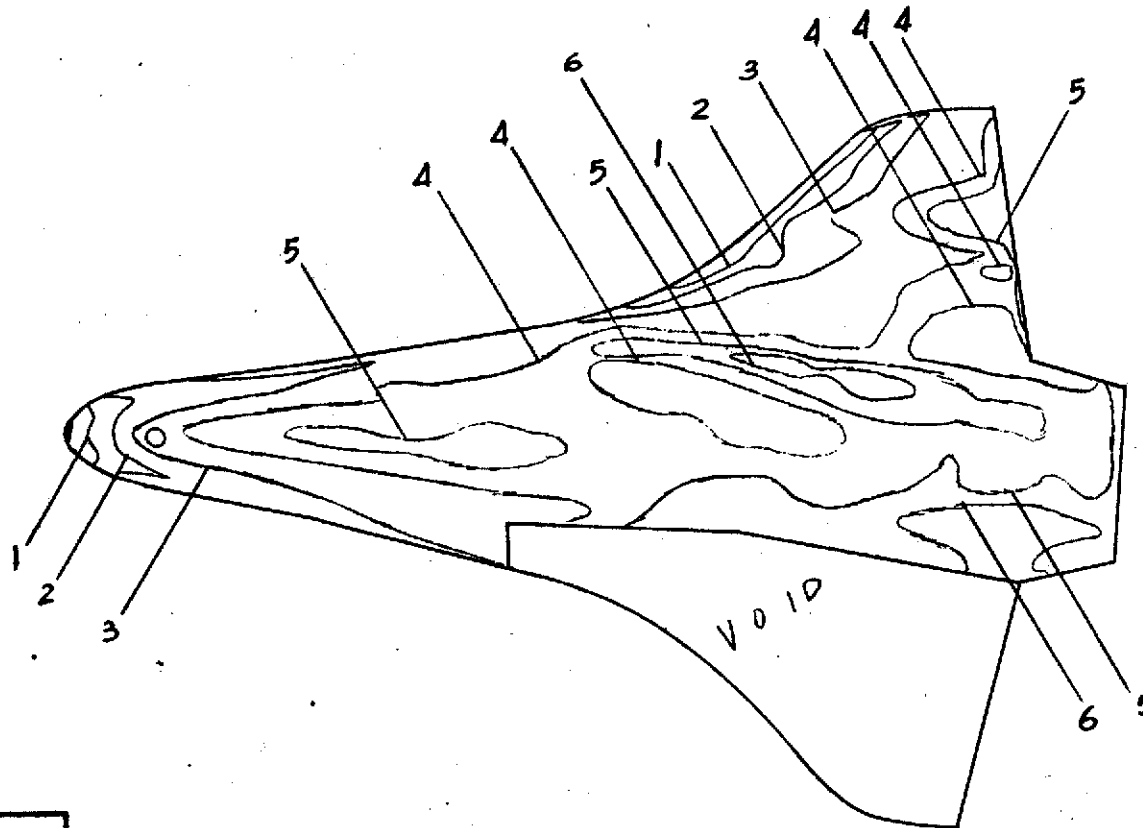
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{m=1}$
1	.2852
2	.1923
3	.1409
4	.1042
5	.0911
6	.0791
7	
8	
9	
10	

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FIGURE 140

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3840

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 684.7$

$T_{total} \text{ (°R)} = 1330$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 300$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

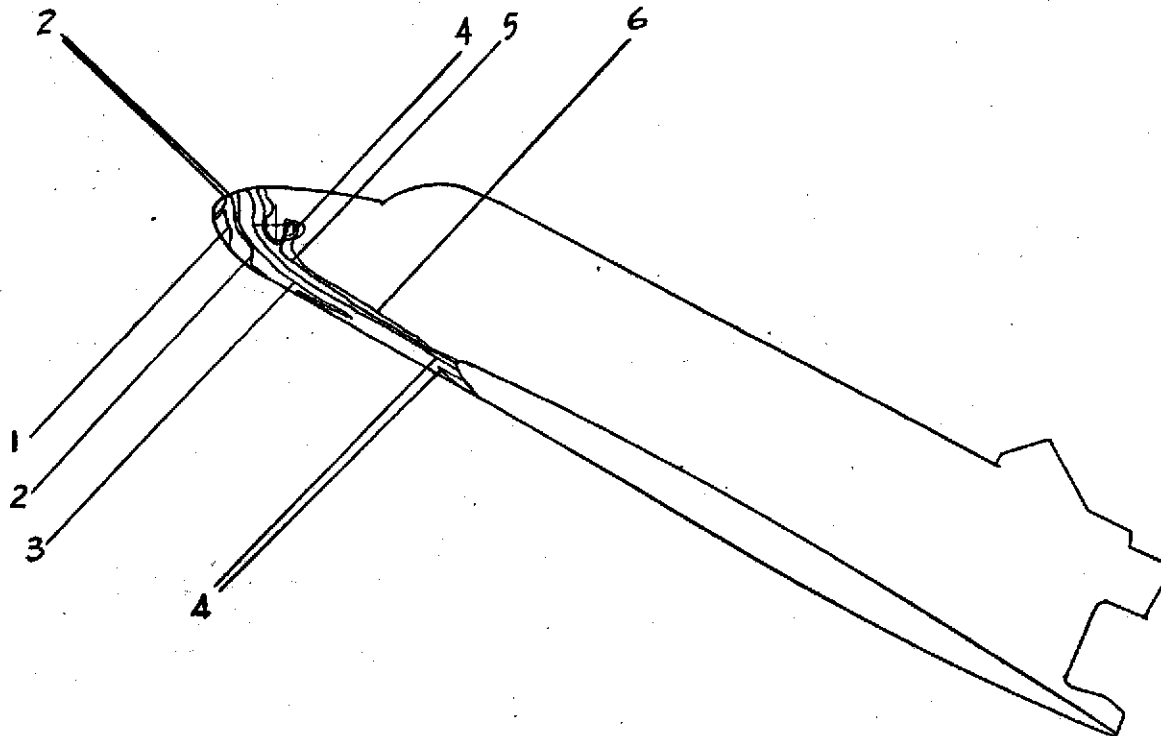
x (in) =

y (in) =

z (in) =

HVD-EVCS

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3506
2	.2395
3	.1694
4	.1312
5	.0978
6	.0830
7	
8	
9	
10	

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FIGURE 141

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3840

$M_\infty = 7.9$

$P_{total}$  (psia) = 684.7

$T_{total}$  (°R) = 1330

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 300

$\alpha = 30$

$\beta = 0$

$\phi = 180$

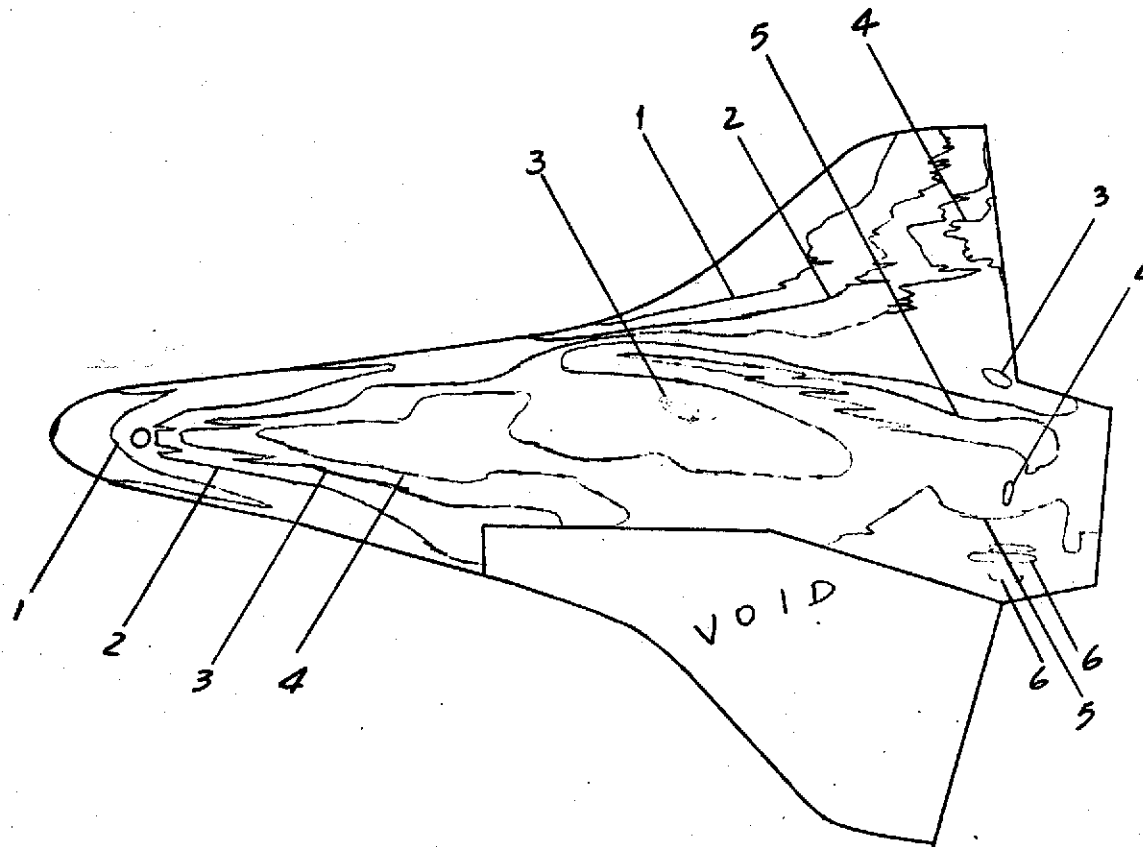
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1474
2	.1131
3	.0932
4	.0816
5	.0719
6	.0612
7	
8	
9	
10	

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FIGURE 142

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3841

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1330$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

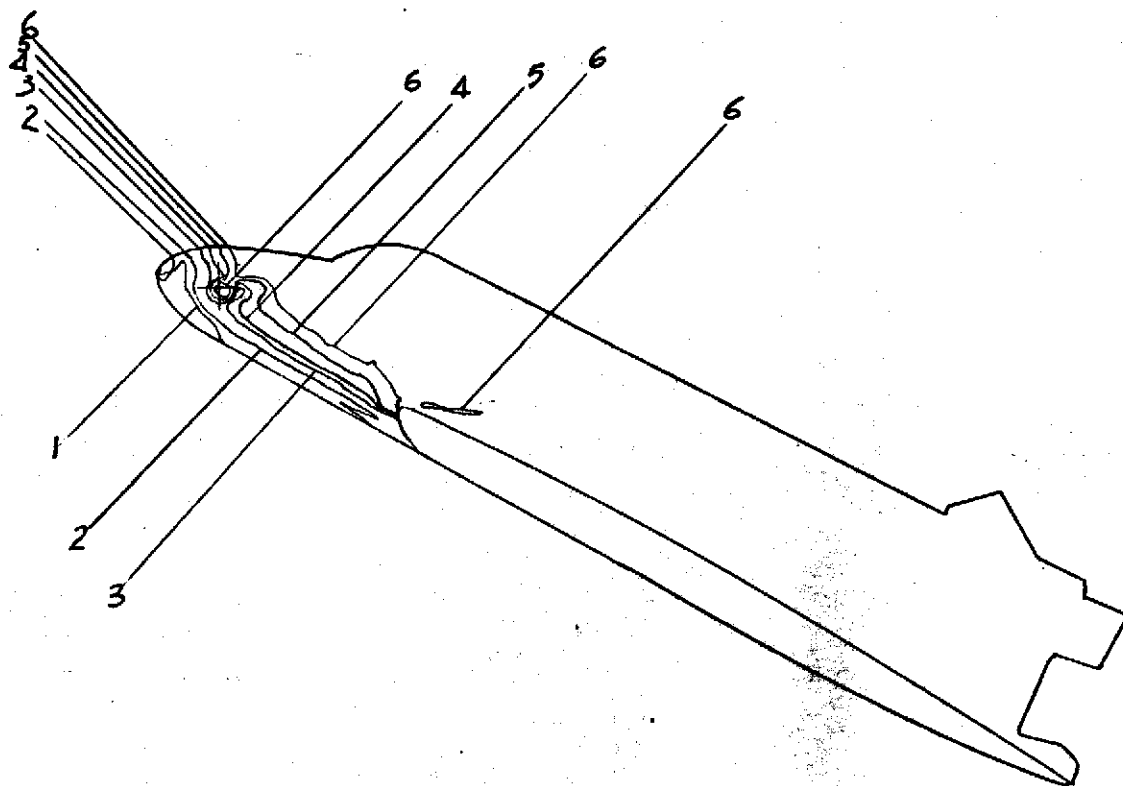
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1688
2	.1379
3	.0844
4	.0675
5	.0503
6	.0427
7	
8	
9	
10	

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FIGURE 143

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3841

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 664.7$

$T_{total} \text{ (°R)} = 1330$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 213$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

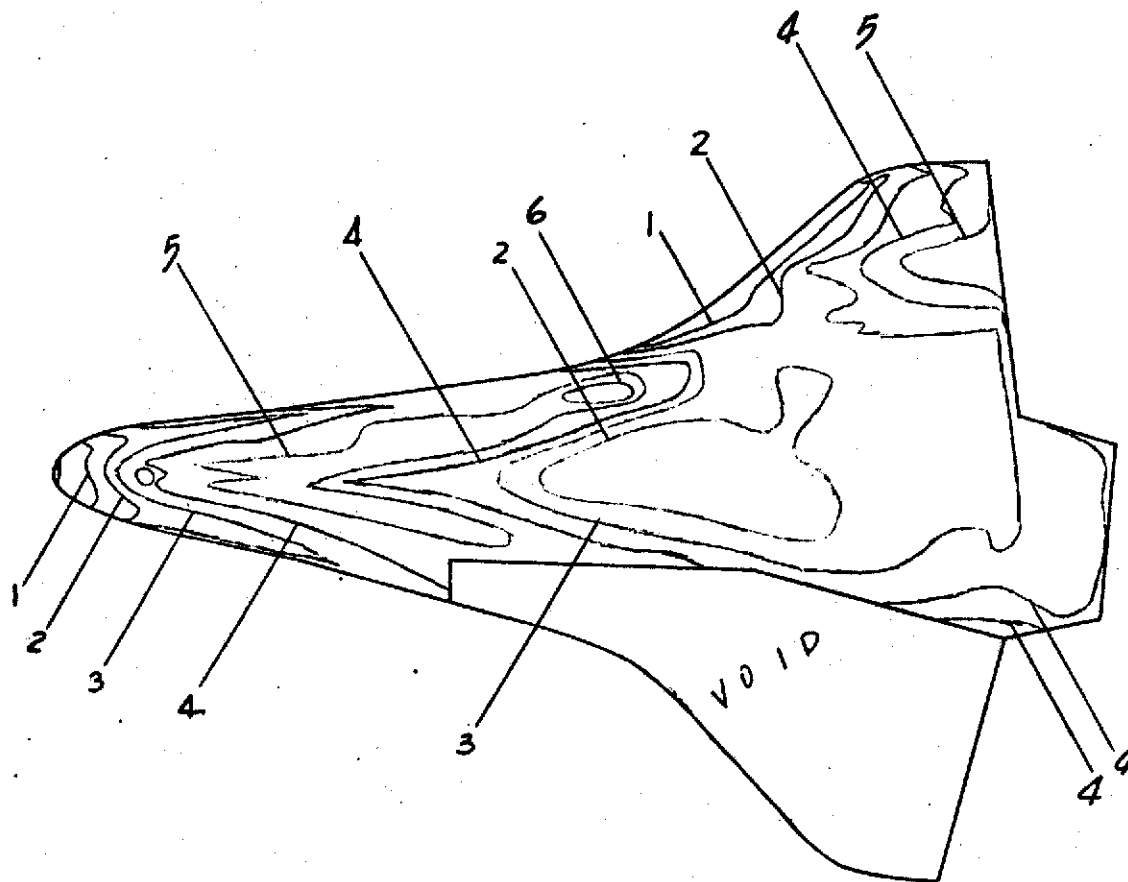
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	.2711
2	.2021
3	.1650
4	.1373
5	.1072
6	.0904
7	
8	
9	
10	

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FIGURE 144

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3842

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1064.7$

$T_{total} \text{ (}^\circ\text{R)} = 1410$

$T_{aw}/T_{total} = .91$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

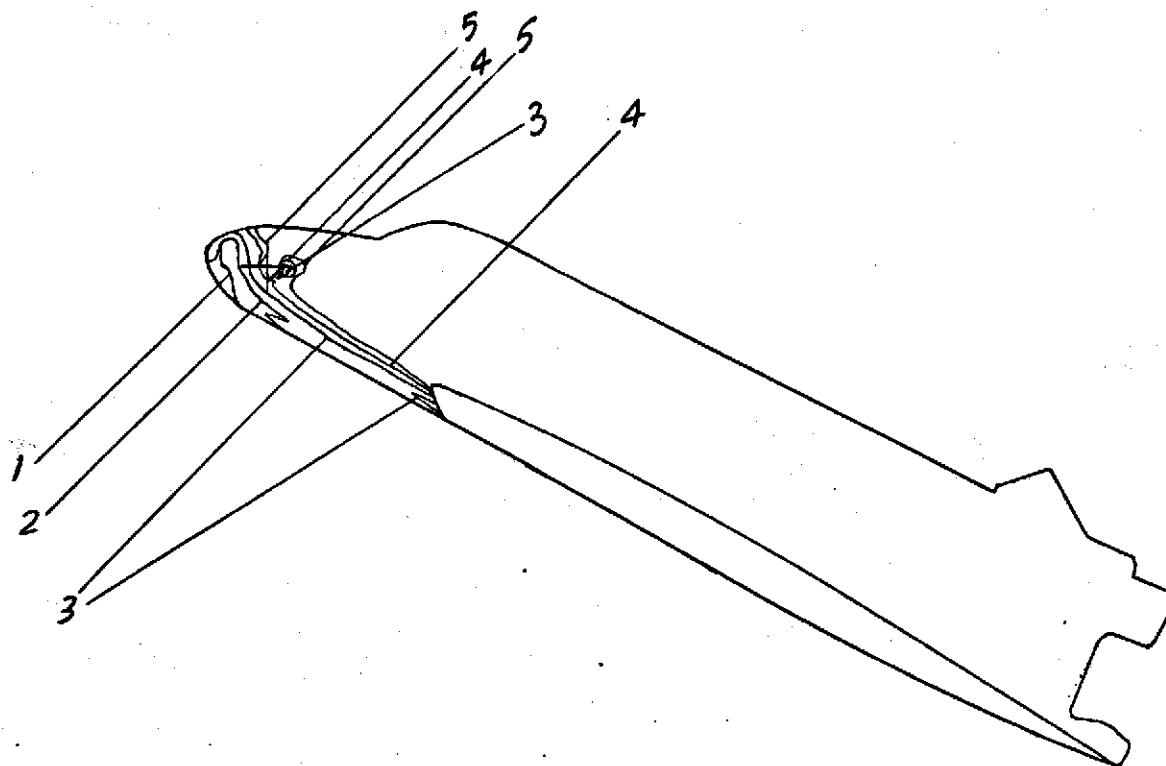
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3117
2	.2023
3	.1490
4	.1138
5	.0860
6	
7	
8	
9	
10	

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FIGURE 145

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC - VDT

TEST

RUN 3842

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1064.7$

$T_{total} \text{ (}^\circ\text{R)} = 1410$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 350$

$\alpha = 30$

$\beta = 0$

$\phi = 180$

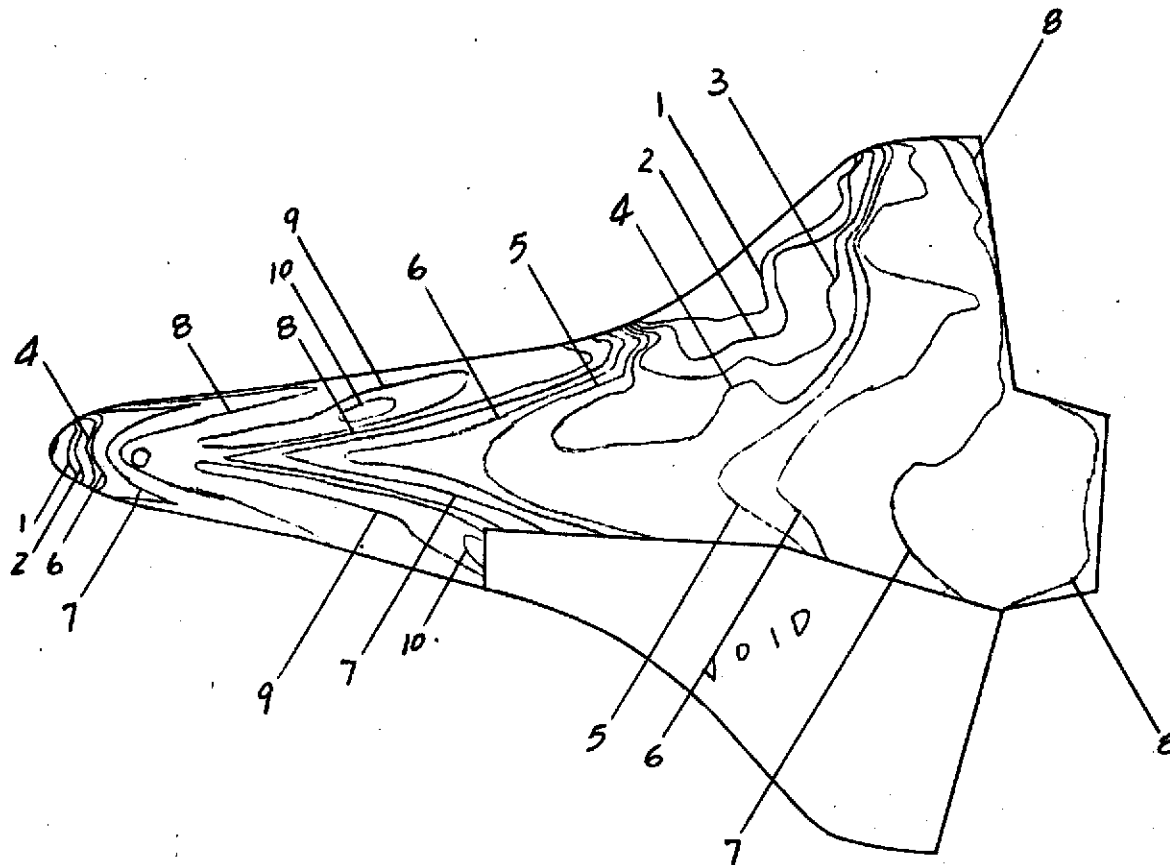
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.3598
2	.3284
3	.2938
4	.2682
5	.2483
6	.2322
7	.1923
8	.1563
9	.1174
10	.1095

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FIGURE 146

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3843

$M_\infty = 7.9$

$P_{total}$  (psia) = 1424.7

$T_{total}$  ( $^{\circ}R$ ) = 1340

$T_{aw}/T_{total} = .91$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 30$

$\beta = 0$

$\phi = 180$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

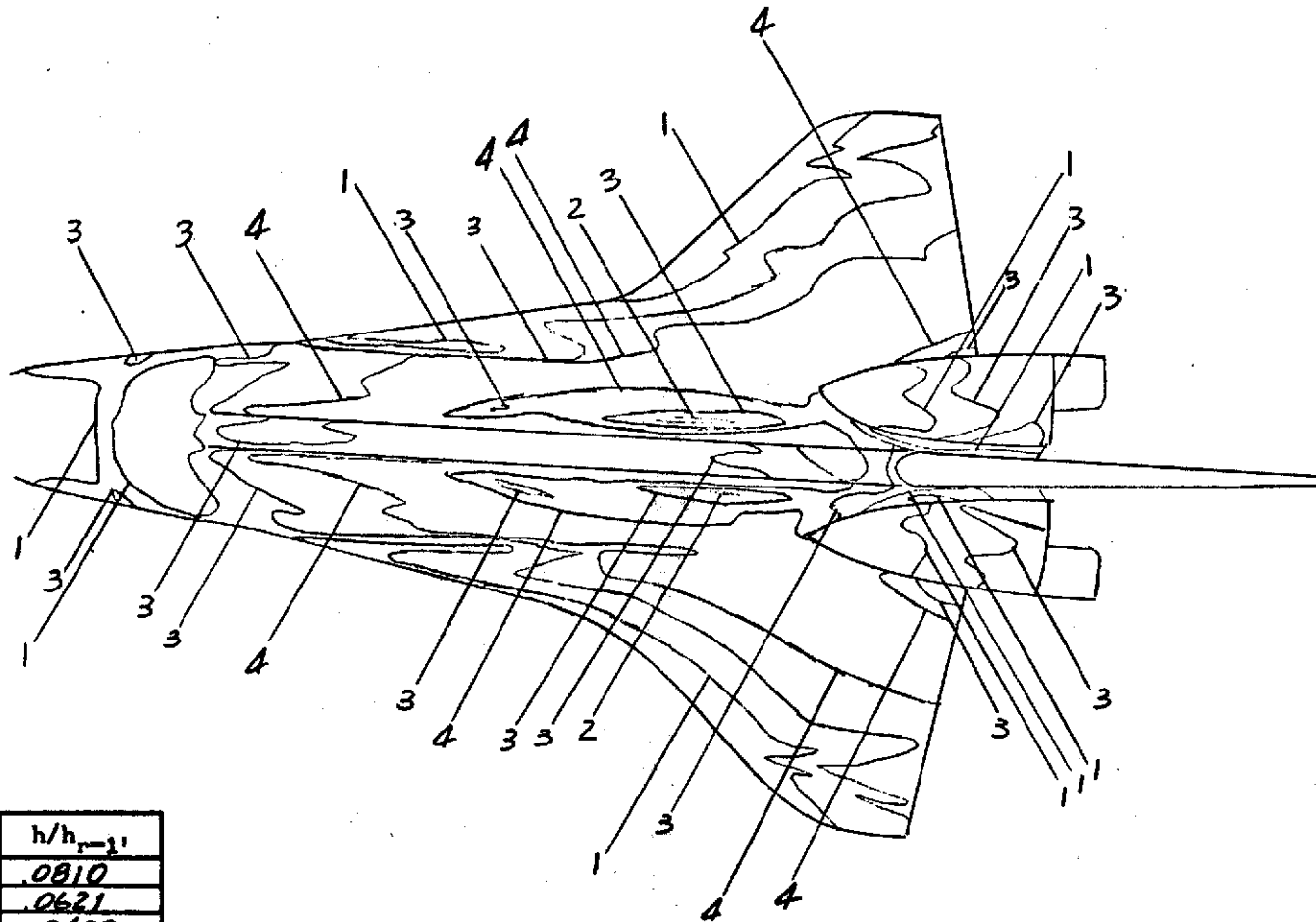
x (in) =

y (in) =

z (in) =



# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0810
2	.0621
3	.0400
4	.0226
5	
6	
7	
8	
9	
10	

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FIGURE 147

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3844

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 634.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1275$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 150$

$\alpha =$

$\beta = 0$

$\phi = 0$

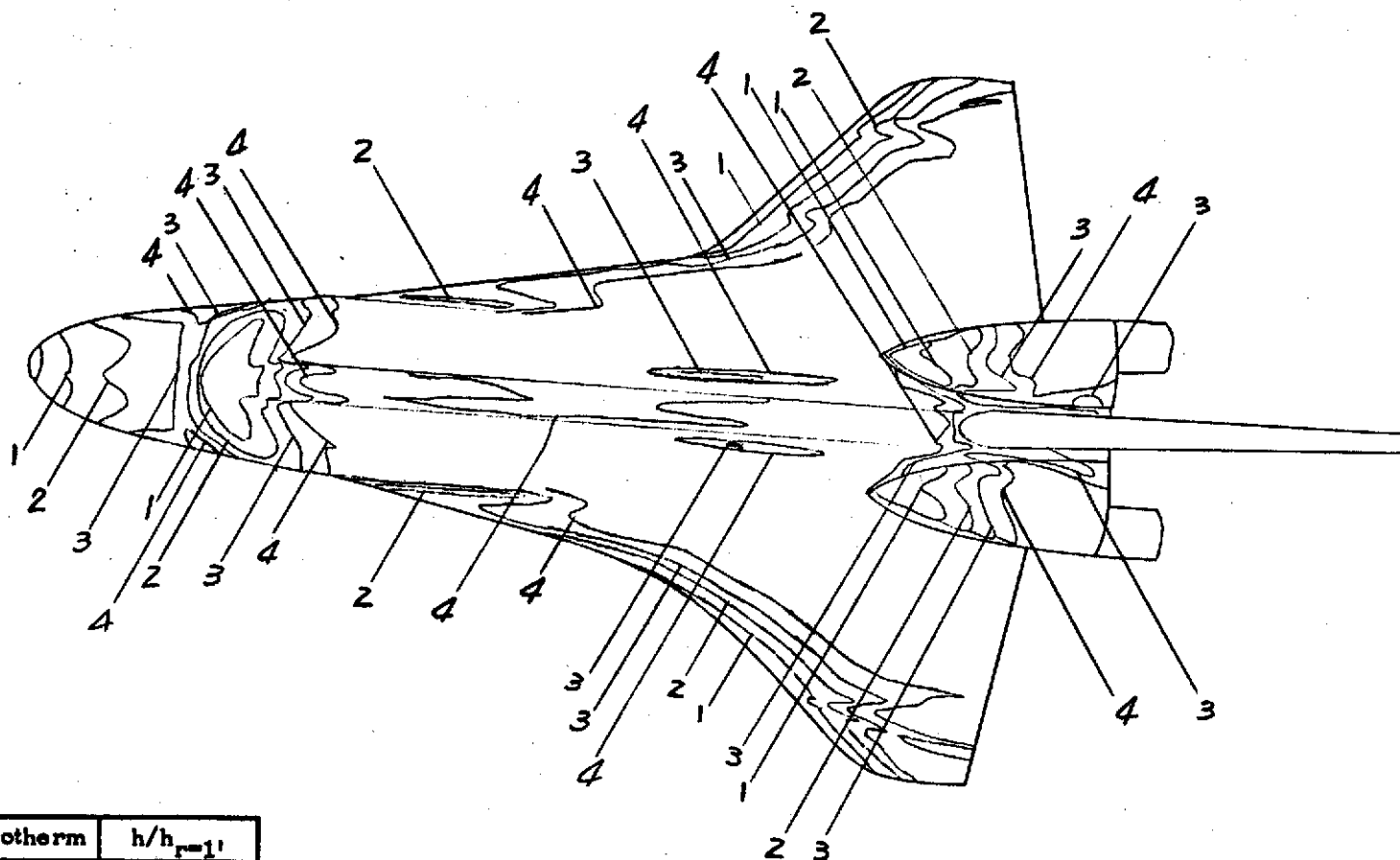
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.1803
2	.1039
3	.0718
4	.0541
5	
6	
7	
8	
9	
10	

PAGE 174  
FIGURE 148

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3845

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 1414.7$

$T_{total} \text{ (}^\circ\text{R)} = 1410$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha =$

$\beta = 0$

$\phi = 0$

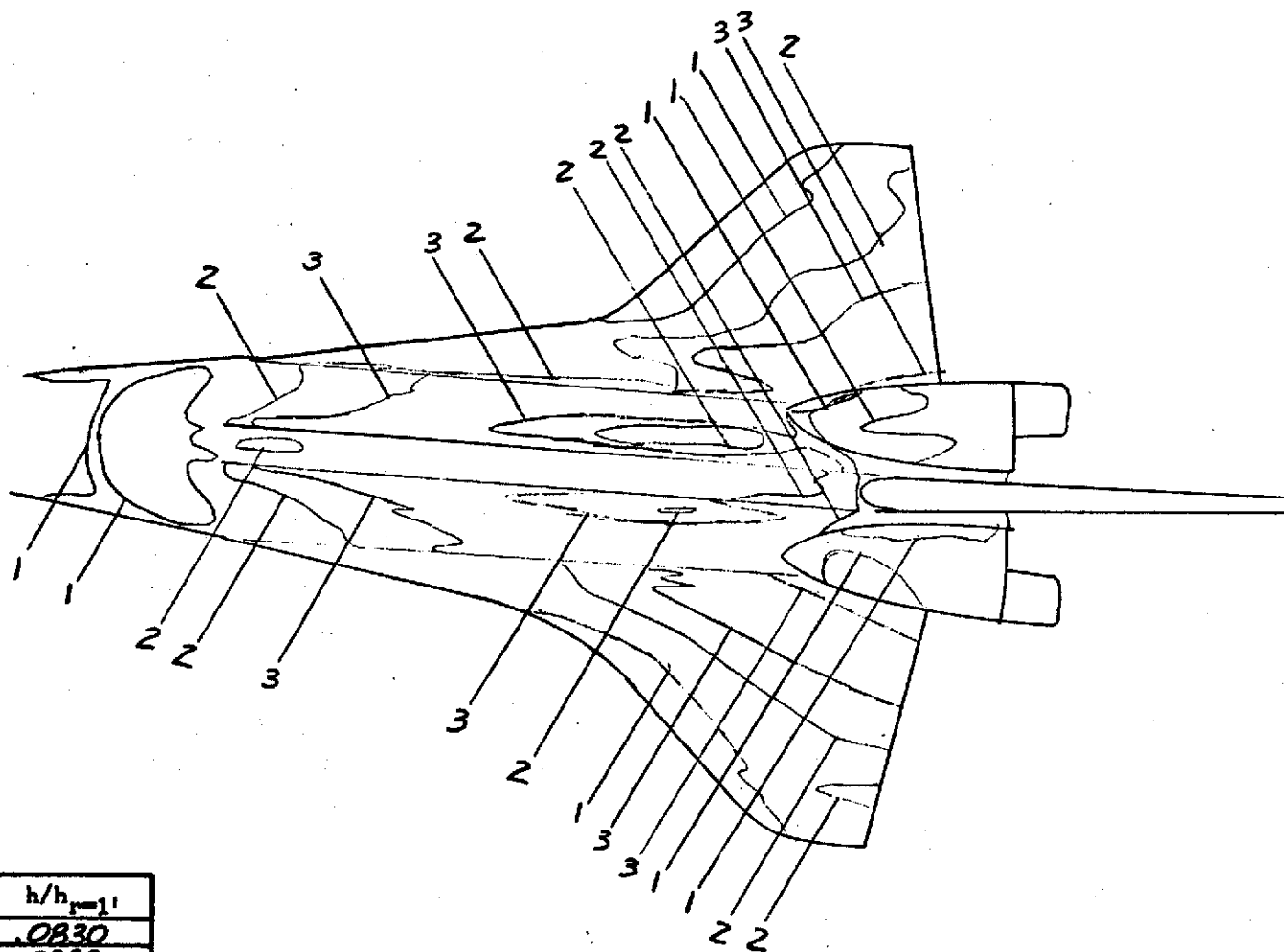
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0830
2	.0333
3	.0214
4	
5	
6	
7	
8	
9	
10	

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FIGURE 149

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3846

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (°R)} = 1210$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{phase \text{ change}} \text{ (°F)} = 119$

$\alpha =$

$\beta = 0$

$\phi = 0$

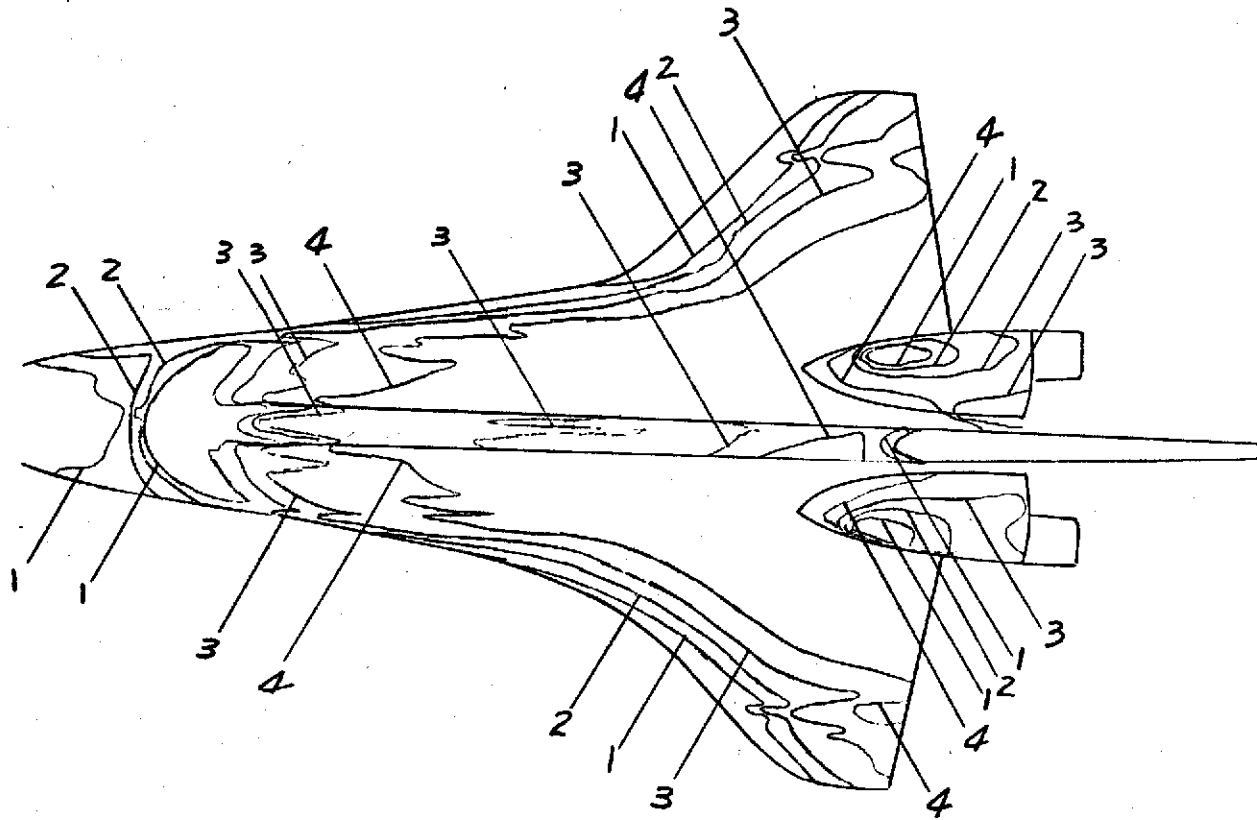
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream;  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0749
2	.0505
3	.0335
4	.0209
5	
6	
7	
8	
9	
10	

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FIGURE 150

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3847

$M_\infty = 7.9$

$P_{total}$  (psia) = 644.7

$T_{total}$  (°R) = 1335

$T_{aw}/T_{total} = .90$

$R_N$  per foot =

$T_{phase\ change}$  (°F) = 150

$\alpha =$

$\beta = 0$

$\phi = 0$

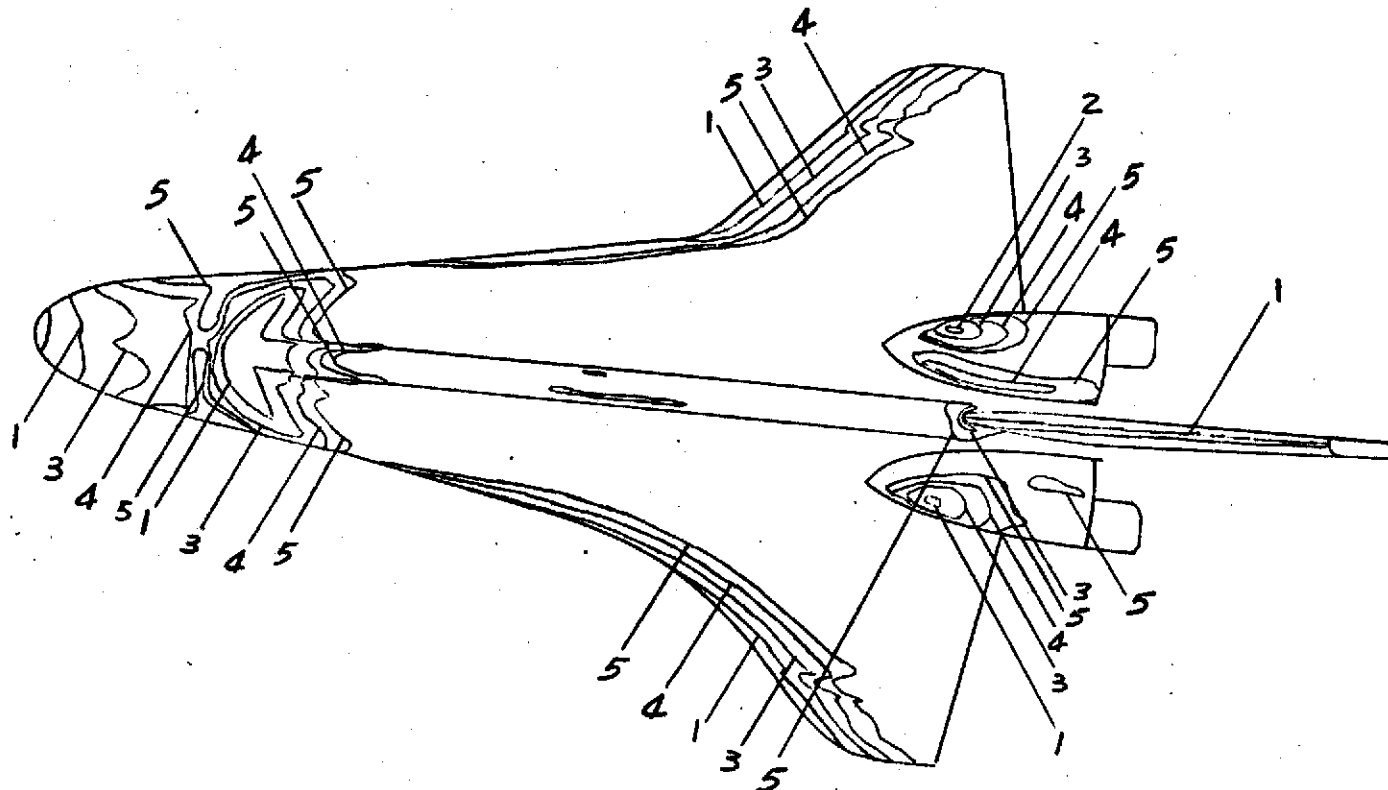
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	.2086
2	.1555
3	.1131
4	.0794
5	.0632
6	
7	
8	
9	
10	

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FIGURE 151

CONFIG.

LENGTH (ft) =

SCALE .006

FACILITY LRC-VDT

TEST

RUN 3848

$M_{\infty} = 7.9$

$P_{\text{total}} \text{ (psia)} = 1414.7$

$T_{\text{total}} \text{ (°R)} = 1340$

$T_{\text{aw}}/T_{\text{total}} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (°F)} = 300$

$\alpha =$

$\beta = 0$

$\phi = 0$

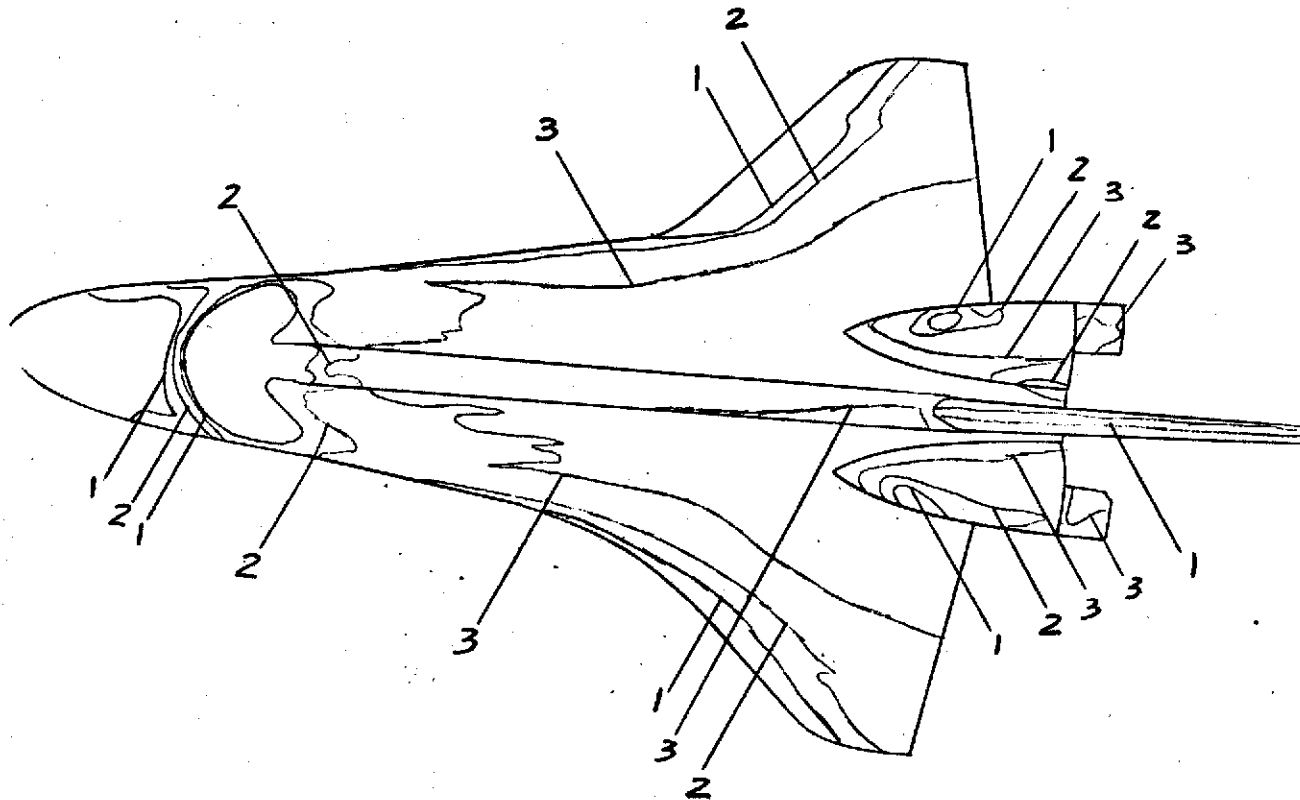
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	.0773
2	.0471
3	.0200
4	
5	
6	
7	
8	
9	
10	

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FIGURE 152

CONFIG.

LENGTH (ft) =

SCALE .006 =

FACILITY LRC-VDT

TEST

RUN 3849

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^\circ\text{R)} = 1235$

$T_{aw}/T_{total} = .90$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 119$

$\alpha =$

$\beta = 0$

$\phi = 0$

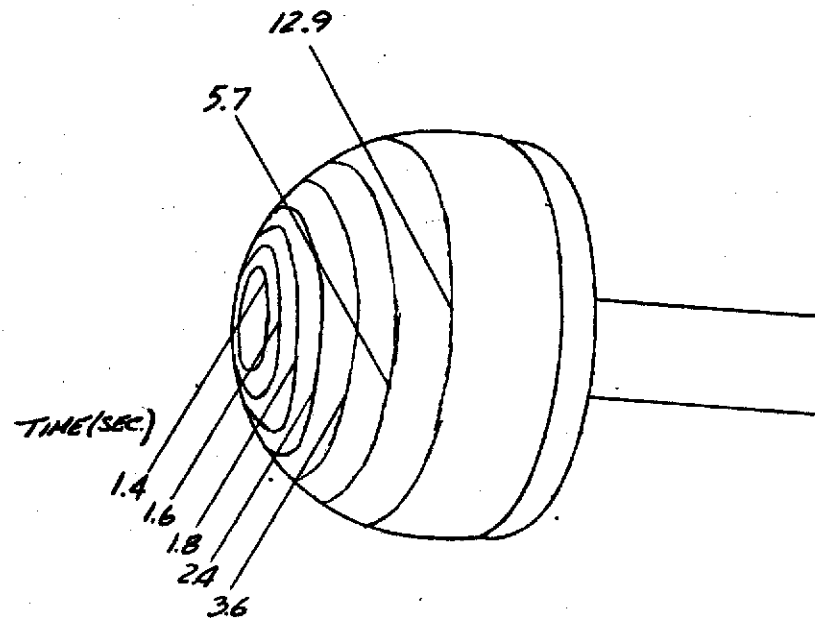
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 153

CONFIG.

LENGTH (ft) =

SCALE FULL

FACILITY LRC-VDT

TEST

RUN 3850

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 639.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1360$

$T_{aw}/T_{total} =$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 300$

$\alpha = 0$

$\beta = 0$

$\phi = 0$

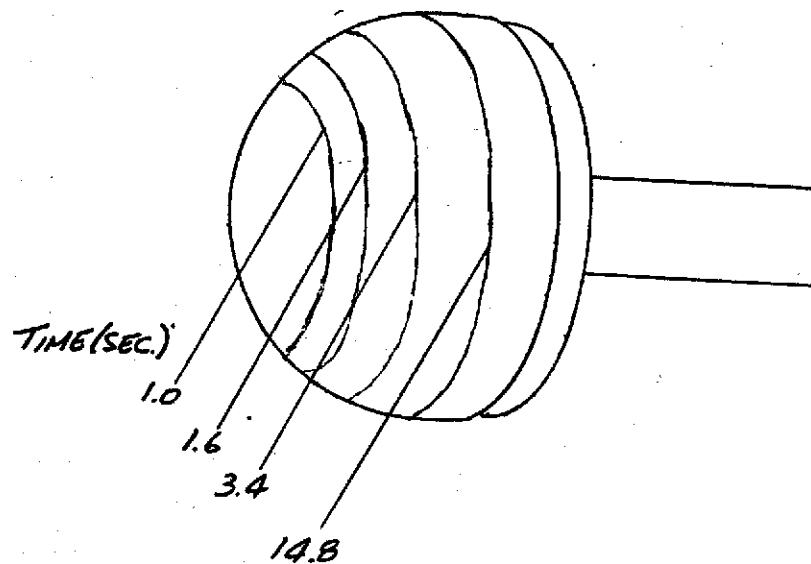
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 154

CONFIG.

LENGTH (ft) =

SCALE FULL

FACILITY LRC-VDT

TEST

RUN 3851

$M_{\infty} = 7.9$

$P_{total} \text{ (psia)} = 174.7$

$T_{total} \text{ (}^{\circ}\text{R)} = 1260$

$T_{aw}/T_{total} =$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^{\circ}\text{F)} = 150$

$\alpha = 0$

$\beta = 0$

$\phi = 0$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

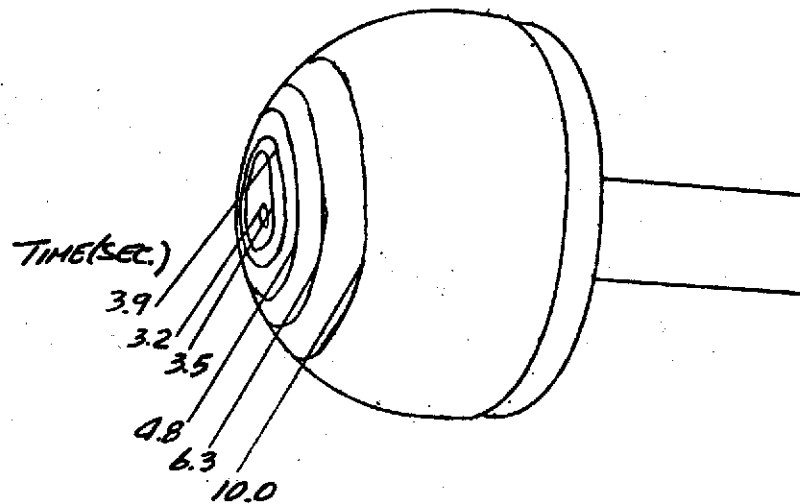
y (in) =

z (in) =

HVD-EVCS



# PHASE CHANGE TEST



Isotherm	$h/h_{p=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 155

CONFIG.

LENGTH (ft) =

SCALE FULL =

FACILITY LRC-VDT

TEST

RUN 3852

$M_o = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}$ R) = 1340

$T_{aw}/T_{total}$  =

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}$ F) = 400

$\alpha = 0$

$\beta = 0$

$\phi = 0$

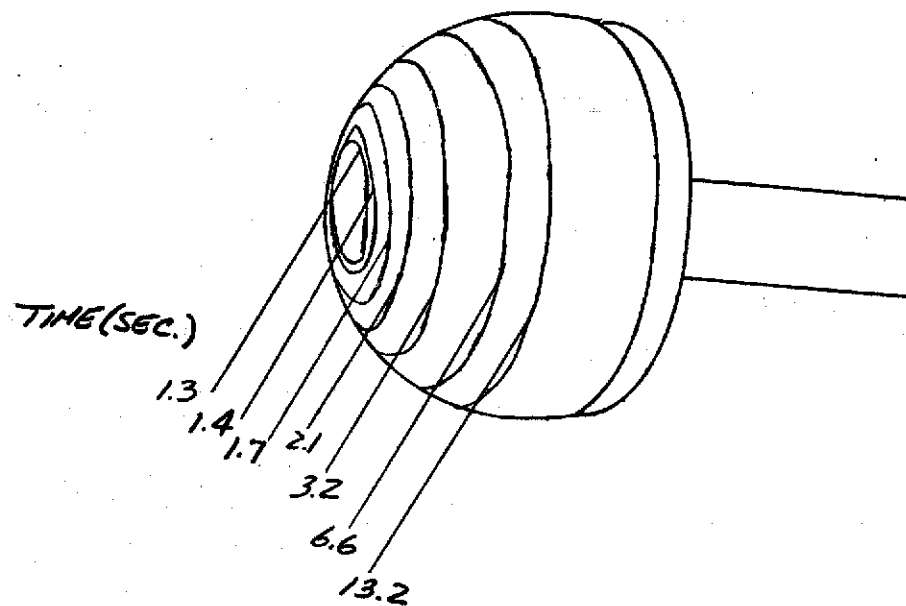
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{ref}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 156

CONFIG.

LENGTH (ft) =

SCALE FULL

FACILITY LRC-VDT

TEST

RUN 3853

$M_\infty = 7.9$

$P_{total} \text{ (psia)} = 644.7$

$T_{total} \text{ (}^\circ\text{R)} = 1345$

$T_{aw}/T_{total} =$

$R_N \text{ per foot} =$

$T_{\text{phase change}} \text{ (}^\circ\text{F)} = 300$

$\alpha = 0$

$\beta = 0$

$\phi = 0$

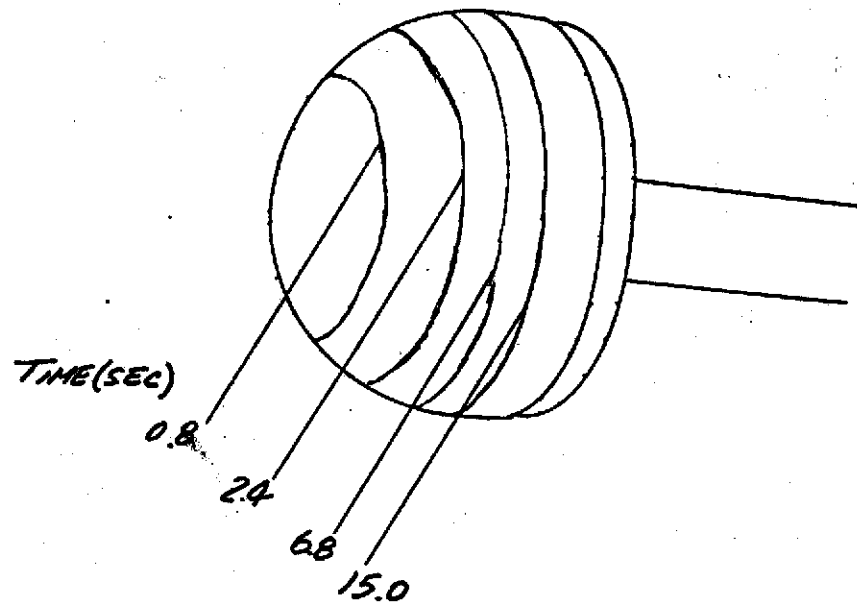
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{f=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 157

CONFIG.

LENGTH (ft) =

SCALE FULL

FACILITY LRC-VDT

TEST

RUN 3854

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 179.7

$T_{total}$  ( $^{\circ}R$ ) = 1250

$T_{aw}/T_{total} =$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 150

$\alpha = 0$

$\beta = 0$

$\phi = 0$

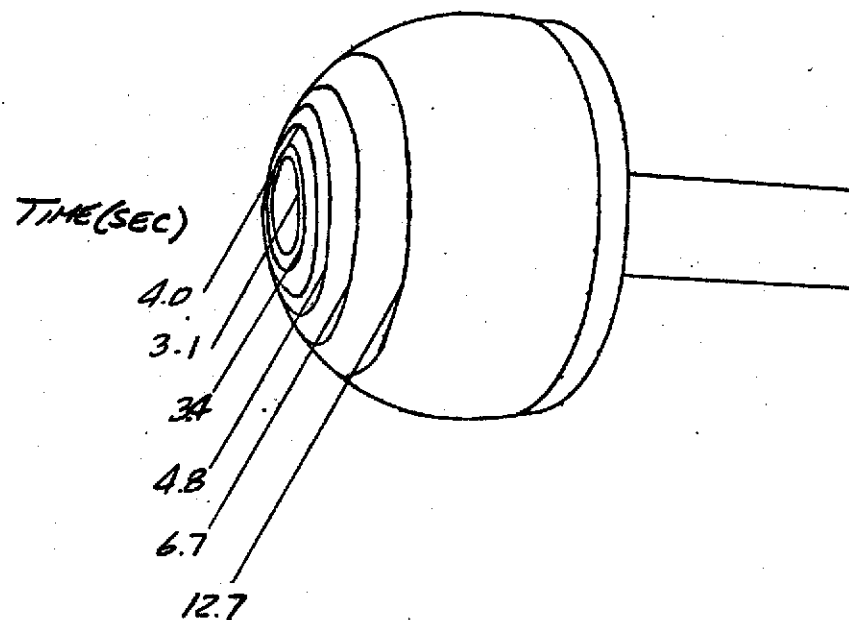
Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

# PHASE CHANGE TEST



Isotherm	$h/h_{r=1}$
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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FIGURE 158

CONFIG.

LENGTH (ft) =

SCALE FULL

FACILITY LRC-VDT

TEST

RUN 3855

$M_{\infty} = 7.9$

$P_{total}$  (psia) = 639.7

$T_{total}$  ( $^{\circ}R$ ) = 1340

$T_{aw}/T_{total} =$

$R_N$  per foot =

$T_{phase\ change}$  ( $^{\circ}F$ ) = 400

$\alpha = 0$

$\beta = 0$

$\phi = 0$

Camera Coordinates (from  
model center, x-axis  
parallel w/ stream,  
+ downstream)

x (in) =

y (in) =

z (in) =

HVD-EVCS